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An Evaluation of Fluid Milk and Cheese Advertising

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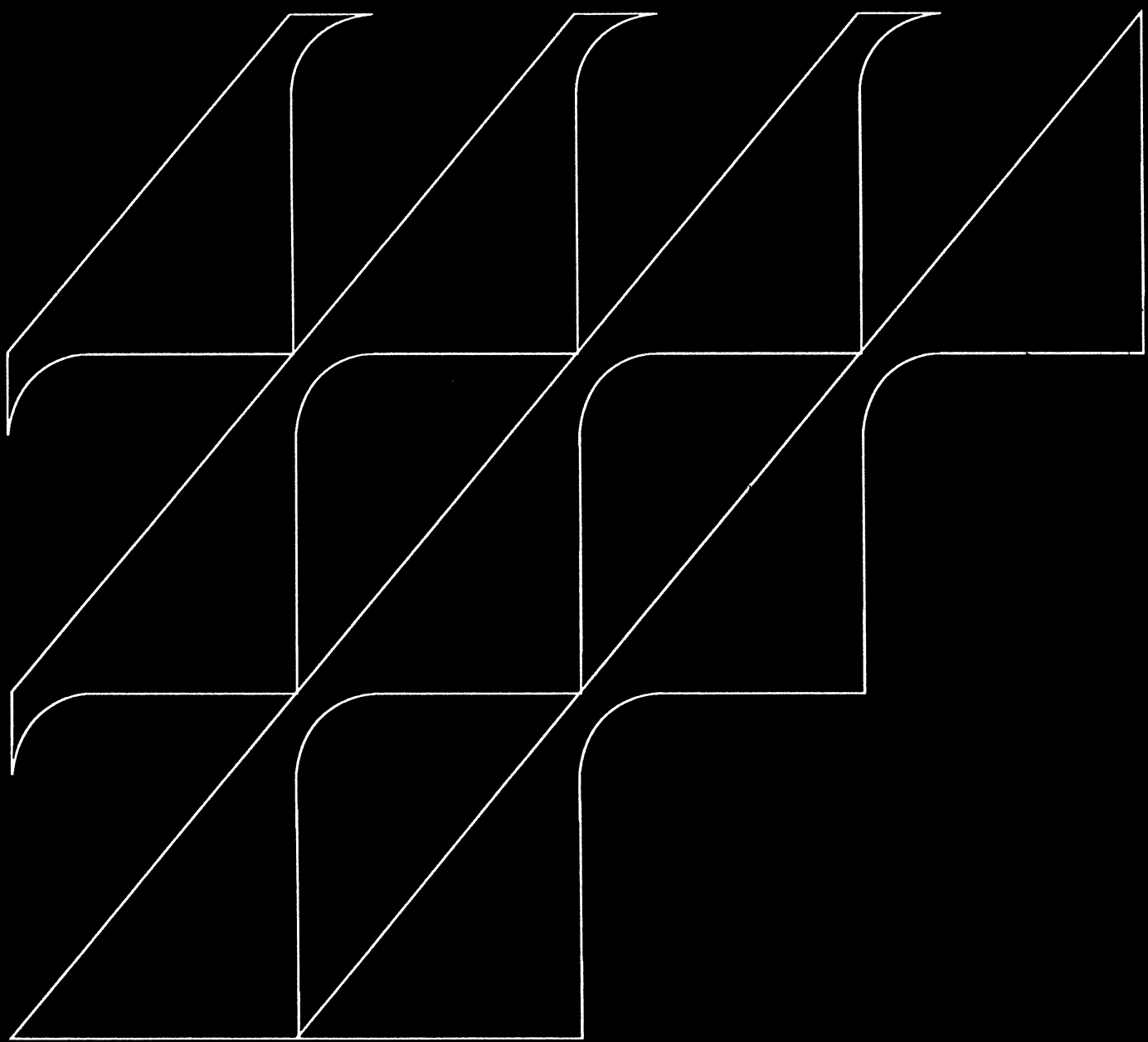

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Abstract

Increased advertising expenditures raised fluid milk sales nearly 5 percent, or by about 7,455 million pounds, during September 1984-September 1991. Sales of natural and processed cheese consumed at home rose by about 25 million pounds and 290 million pounds in the same period because of increased generic advertising. An assessment of 15 cents per hundredweight of milk sold commercially, mandated by the Dairy and Tobacco Adjustment Act of 1983, funded the increase in advertising. The authors use econometric demand models to control for variables that influence the demand for milk and cheese. These variables include generic and branded advertising, market prices, income, and demographic characteristics.

Keywords: Cheese, fluid milk, advertising, demand, entry, exit, distributed lag, econometrics, simulation, elasticities.

Acknowledgments

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Summary

Increased advertising expenditures raised fluid milk sales by about 4.7 percent or by 7,455.4 million pounds, during September 1984-September 1991. These sales were for milk consumed through all outlets in 12 markets. Sales of natural and processed cheese consumed at home rose by about 25 million pounds and 290 million pounds in the same period because of increased generic advertising. An assessment of 15 cents per hundredweight of milk sold commercially, mandated by the Dairy and Tobacco Adjustment Act of 1983, funded the increase in advertising. The authors use econometric demand models to simulate these results. Model variables include generic and branded advertising, market prices, income, and demographic characteristics.

Simulations also indicated that declining real fluid milk prices in the period increased fluid milk sales by 946 million pounds, and increasing real incomes raised fluid milk sales by 3,286 million pounds. In the cheese market, declining real prices of natural cheese increased sales by about 1,082 million pounds. Increasing real incomes raised natural cheese sales by 87 million pounds and processed cheese sales by about 11 million pounds.

The econometric milk model used in the simulation shows that a 10-percent increase in milk retail prices would result in a 1.5-percent decrease in retail milk sales. A 10-percent increase in per capita real income would result in a 2.5-percent increase in retail milk sales.

Females, households with children under 18 years of age, and single-person households drink more milk than the national average; black and rural households drink less. As the average level of education of the population increases, the quantity of milk consumed tends to decline.

The underlying assumption for the fluid milk model is that generic fluid milk advertising has a 12-month lagged effect and that the cumulative lagged effects changed after the implementation of the 1983 Act. Estimates indicate that the postact cumulative advertising effect is generally higher than before the act. The cumulative effect is highest in the first time interval (September 1984-July 1985) of the postact period, and declines slowly afterward. In the first time interval of the postact period, a 10-percent increase in advertising expenditures would eventually increase consumption by 7 percent. During the last time interval of the postact period (August 1990-September 1991), a 10-percent increase in advertising expenditures would induce less than a 6-percent increase in consumption.

The analysis also indicates that per capita milk consumption for the 12 regions followed a downward trend in the preact period. During the immediate periods following passage of the act, per capita consumption increased. But, the rate of growth has not been maintained in recent years.

The econometric models for cheese include tests of entry and exit of consumer demands for the natural and processed cheese. Generic advertising of cheese does not influence households that normally purchase natural cheese to increase their purchases, but it does influence households that do not normally purchase cheese to purchase natural cheese. Advertising affects the number of households that purchase processed cheese and leads to increased purchases by those households that normally purchase processed cheese.

An Evaluation of Fluid Milk and Cheese Advertising

Theresa Y. Sun
James R. Blaylock

Introduction

Generic promotion has become an important marketing tool for many agricultural commodities. The Dairy and Tobacco Adjustment Act of 1983 sets down the legislation for assessing all dairy producers 15 cents per hundredweight of milk for commercial sale. These funds are to be used to support research, promotion, and nutrition education for fluid milk and milk products. To assess the effectiveness of the promotion program, we have conducted empirical estimation of the effect of advertising for cheese and fluid milk.

Most dairy advertising studies have typically estimated models for one specific region (Thompson and Eiler, 1977; Kinnucan and Forker, 1986; Liu and Forker, 1988). For the aggregative national fluid milk advertising analysis, Ward and Dixon (1989a, 1989b) used a 12-region pooled time-series cross-sectional model. The 12-region sales database enables the fluid milk model to encompass variations of price and quantity among various regions.

On the other hand, Blaylock and Blisard (1988) studied the effects of advertising on cheese sales with panel data from the Market Research Corporation of America. These data enabled not only an approximation of the advertising effects at the aggregate national level, but also an examination of the entry and exit of consumers in the cheese market. This report updates (and refines) these models to provide current information on the analysis of the effects of generic and branded advertising on fluid milk and cheese. It also serves as background information for the report to Congress on the effects of advertising.

This report details the following objectives of our research:

- Examine the current and carryover effects of advertising on the demand for fluid milk and cheese.
- Determine if the effect of advertising changed structurally over time.
- Examine if advertising affects the rate of consumers entering or exiting the cheese market.
- Simulate changes in consumption of milk and cheese since 1983 for changes in advertising, price, and income.

We followed earlier analyses to hypothesize a second-order polynomial distributed lag structure for the carryover effects of advertising variables in the cross-sectional time-series model for fluid milk. Advertising would also cause primary (advertising) and secondary (time-trend) structural changes after the enactment of the act. Earlier analyses assumed that both primary and secondary structural changes, in the form of shifting advertising and time coefficients, would occur every 12 months after the act. In the current analysis, secondary effects of structural change occur with less frequency. Assuming autocorrelated error terms within each region and contemporaneous error terms across regions, we estimated the model with a generalized least-squares procedure. Data for the model extends from December 1978 through September 1991.

Results indicate that the shortrun advertising effect is highest after a 6-month period for fluid milk. The shape of the shortrun advertising effect is flatter before the act than after the act. To examine the dynamics

of the advertising effect, we separated the postact period into seven time intervals. The advertising multiplier (cumulative advertising effect) is highest during September 1984-July 1985, the period immediately after the act. Afterwards, the cumulative effect tapers off at 12-month intervals. The secondary structural change, as measured through changes in time trend, is positive and constant. This positive trend effect is a reverse of milk consumption trend before the act, which is negative.

If we assume that real advertising expenditures are fixed at the level of the 12-month interval immediately preceding the act and compare the simulated results with those obtained from the passage of the act, the simulated increase in milk consumption resulting from the act for September 1984-September 1991 is 7.45 billion pounds. If deflated per capita price or income is the same as that in the 12-month interval immediately before the act, simulated gains because of lower prices are 945 million pounds of fluid milk, and gains because of higher income are 3.3 billion pounds. The total increase in advertising spending since the act is $178.5 million. These simulations are based on the 12 regions, which represent 40 percent of national fluid milk consumption.

We specified three equations for both natural and processed cheese: market demand, average-quantity demand, and demand in terms of proportion of purchasing consumers. Data include at-home consumption from January 1982-June 1991. We assumed a gamma-distributed lag with no length restriction for the carryover effects of both generic and branded advertising expenditures.

Results for natural cheese demand indicate that branded advertising was statistically significant in increasing the demand for natural cheese. Generic advertising influences consumption only in the current period. We found no evidence that the coefficients of generic advertising have changed over time.

Branded and generic advertising variables separately do not have meaningful effects on processed cheese consumption. However, when combined, advertising had a statistically significant influence on total cheese consumption. This influence was largest in the current month and declined slowly, with 12-month-old advertising having about 40 percent of the effect of current period advertising.

The most influential economic factors affecting the proportion of households entering the natural cheese market were the price index for meat, the price of processed cheese, and generic advertising. Generic advertising increased the proportion of consumers entering the natural cheese market, but it did not induce those already in the market to increase their purchases. For processed cheese, the combined generic and branded advertising has evidently increased the proportion of consumers in the market and has induced those already using processed cheese to increase their purchases.

Background on Advertising

Advertising is directed toward existing and potential consumers of a product with the objective of increasing sales. "Branded" advertising promotes the particular characteristics of a given "brand" of the commodity. "Generic" advertising promotes consumption of the general commodity by a cooperative effort of producers.

Sheth (1974) identifies four separate mechanisms through which advertising produces potential changes in consumer demand: precipitation, persuasion, reinforcement, and reminder. Precipitation encourages consumers to become buyers of a product. Persuasion encourages consumers to choose among alternative "brands" within a product category. Reinforcement continually directs the consumer's attention to a particular brand or product. A reminder encourages consumers to become repeat purchasers of the product. Ward, Chang, and Thompson (1985) note that generic advertising is intended to precipitate and remind, and branded advertising is intended to persuade and reinforce. The reminder and precipitation functions are more likely to increase total industry sales, and persuasion and reinforcement are generally associated with maintaining or increasing market shares.

Some evidence, at least for a few commodity groups, suggests that generic advertising increases aggregate demand or at least reduces the rate of decline in consumption (Ward and Myers, 1979; Thompson, 1975; Ward, 1984). The empirical evidence that branded advertising is effective in increasing aggregate demand is

less persuasive. Generic advertising, in theory, is brand neutral, but this neutrality may not exist if generic promotion emphasizes the common characteristics of a product group, and a concurrent branded advertising campaign stresses differences. Also, if one firm dominates the branded advertising for a particular product (such as in the processed cheese market), branded advertising may be serving both as a form of branded and generic promotion. Concurrent generic and branded advertising campaigns can have both complementary and competitive aspects, depending on the commodity and the nature of the promotion activities.

Ward, Chang, and Thompson (1985, p. 275) attribute the following traits to generic advertising:

(1) Generic advertising encourages consumption and repeat purchases of a product category.

(2) Generic advertising provides information about product groups and would generally be expected to be less persuasive (and less deceptive) than branded messages.

(3) Generic advertising probably has more factual information than branded advertising, but it is still oriented to high recall versus the kinds of messages one would expect from promoting infrequently purchased goods.

(4) Generic advertising may have a negative effect on product differentiation, thus reducing barriers to entry and excessive profits (and margins) among first handlers beyond the farmgate.

(5) Generic advertising will probably force brand advertisers to concentrate on product attributes (whether real or fancied) that are more difficult for the consumer to verify.

(6) Generic advertising may provide producers and smaller firms with a mechanism for benefiting from any economies of scale.

The Theory of Demand with Advertising

The classical theory of consumer demand is based on the assumption that individual consumers allocate expenditures on commodities as if they had a fixed, ordered set of preferences described by an indifference map or by ordinal utility function. Consumers maximize this utility function subject to restraints imposed by the money income they receive and the prices they must pay. The result of this process is a set of demand relations, one for each commodity, which are functions of all prices, income, and other demand factors. Few empirical analyses have attempted to estimate a complete system of consumer demand functions for food. Notable exceptions include Brandow (1961), George and King (1971), and Huang (1985). Most analyses use weakly separable utility and multiple-stage maximization, where the utility function is partitioned into separate subsets or branches for the commodity product groups (Pollak, 1971). The empirical implication of the multistage utility maximization hypothesis is that the demand functions for individual commodities within a branch can be specified as a function of the prices of the goods in that branch and total expenditures for goods in the branch. Such demand functions are called conditional to highlight the fact that the effects of total income and prices of goods outside the branch enter the group demand functions through the budget allocation for goods in the branch. An advantage of the conditional demand function formulation is that, once the budget allocation to goods within the branch is known, prices of goods outside the branch can be ignored.

The above theory of consumer demand does not explain the consumption behavior of individuals when their preferences are changed, either autonomously or by advertising and other sales efforts. Two approaches for incorporating advertising into the neoclassical theory of demand have predominated in the economic literature: the "advertising as utility altering" approach and the "advertising as information" approach. Neither of these approaches has reached a refined state of theoretical or empirical development. To the extent that advertising enters into and alters the utility function, the issue revolves around how to treat that entry. In other words, should advertising itself be an object of preferences (thus a direct generator of utility) or does it shift preferences? Tintner (1952) and Ichimura (1950-51) defined a change in preferences by a

change in the form of the ordinal utility function. Basmann (1956) chose to treat advertising as not entering the utility function directly, but rather as uniquely controlling a set of parameters that determine the form of the utility function. Dixit and Norman (1978) envision utility functions with goods and any advertising on these goods as arguments. As Rosen (1980) pointed out, because no economic theory exists that systematically explains the process by which advertising affects consumers' tastes and preferences, modeling the effects of advertising via the utility function lacks theoretical objectivity.

The "advertising as information" approach, refined by Verma (1980) and summarized by Rosen (1980), is grounded in household production theory, where utility is a function of product characteristics rather than the products directly. Under such a theoretical concept, the demand for observed goods (market products) is derived from the demand for commodity attributes. Efficient matching of desired attribute bundles to market products requires information about attributes embodied in various products and about the corresponding prices. The process of gathering, analyzing, and producing information relevant to the household production function means that information and time are supplied in the same manner as product attributes in the household production function. Because advertising to which consumers are exposed conditions information, advertising plays the role of an exogenous shift variable in the household's production functions for information and hence ultimately for commodities (product attributes).

The outcome of this line of reasoning is that advertising variables, in addition to the usual price and income variables, are arguments of the consumer's demand functions for market goods. The appealing aspect of this approach is that it views advertising as increasing the endowment of a productive factor, which makes purchased market goods and time more productive in generating ultimate commodities (product attributes). Thus, consumers are logically more prepared to sacrifice some income or are willing to pay higher prices for advertised goods, a basis for normative welfare that is vastly different from the position one is led to if advertising directly and capriciously alters underlying preferences.

Entry and Exit in Commodity Demand

In the preceding discussion of the theory of advertising demand, we did not examine the effects of entry and exit on market demand. Entry and exit theory deals with the effects of individual consumers or households beginning or ceasing to purchase a given commodity. Not all consumers will purchase a given commodity at all prices. Rather, some consumers will choose not to purchase any of a given good at certain relative prices. Advertisers may try to increase consumption by getting more consumers to enter the market, by getting those already in the market to increase their purchases, or both. The influence of other variables in the demand function, such as prices and income, may also change over time, thus inducing some individuals to decide to enter, and others to decide to exit, the market.

Haidacher (1964) developed a technique for analyzing the effects on the demand for a given good due to consumers entering and exiting the market. The method focuses on decomposing the conventional aggregate market demand Q with respect to the entry-exit phenomenon. Let the maximum number of potential consumers in the market be fixed as N, and the number of consumers actually purchasing the product be given as r. Then, at prices above some minimum level, N-r consumers will not purchase the commodity. The proportion, Pr, of consumers purchasing at a given price is r/N. In addition, let q_i be the purchase of individual i. The average quantity, q, purchased by individuals in the market is then:

$$q = 1/r \sum q_i \qquad (1)$$

The summation of q_i over all consumers in the market is the aggregate market demand Q:

$$Q = q * r \qquad (2)$$

Substitute r = Pr*N into the above equation, and we have:

$$Q = q * Pr * N \tag{3}$$

Let the market price elasticity of demand for good i be:

$$E_Q = \delta Q/\delta P_i * P_i/Q \tag{4}$$

Using equation (3) for Q and applying the product differentiation rule, the price elasticity of demand for good i expressed in terms of the entry-exit phenomenon is:

$$E_Q = (\delta q/\delta P_i) * P_i/q + (\delta PrN)/\delta P_i * P_i/(PrN) \tag{5}$$

Because N is constant, the equation may also be written as:

$$E_Q = \delta q/\delta P_i * P_i + \delta Pr/\delta P_i * P_i/Pr \tag{6a}$$

or

$$E_Q = E_q + E_{pr} \tag{6b}$$

Equation (6b) indicates that the own-price elasticity of demand for a good consists of two components: the price elasticity of average quantity purchased by consumers in the market, and the price elasticity of the proportion of total consumers in the market.

Thus, to examine consumer behavior with respect to market entry and exit for a good, two additional demand schedules need to be examined: an average quantity demand equation where the average quantity bought by consumers is related to price and other demand factors, and a demand equation relating the percent of consumers in the market to demand determinants. As demonstrated, these two equations are a breakdown of the ordinary demand curve. The same variables that enter into the ordinary demand curve are expected to enter into the average quantity purchased curve and the proportion of consumers in the market curve. In a log-linear demand framework, the summation of the estimated coefficients for a given variable from the two curves should equal the corresponding estimated coefficient in the ordinary demand curve.

The empirical application of theoretical demand models is conditioned on data and other empirical restrictions. In the demand analysis for cheese, the data include both information on the average quantity of cheese purchased by consuming households and the proportion of households buying cheese. Thus, we can examine the entry and exit relations for cheese demand by the proportion of consumers entering the market, and the average quantity purchased by those already in the market. Data for the fluid milk market model, on the other hand, are obtained from selected regional time-series data. A cross-sectional time-series model is thus used for fluid milk, and entry/exit cannot be examined.

Empirical Fluid Milk Demand Model

The pooled cross-sectional and time-series model for fluid milk uses data from 12 different regions that encompass over 40 percent of national consumption. Because of the wide range of regional demographic characteristics, in addition to price, income, and advertising, we specify demand for fluid milk to depend also on seasonality, demographic characteristics, and a time trend.

Lagged Distribution of Advertising Expenditures

One may regard advertising expenditures as affecting demand with some sort of distributed lag. To a certain extent, advertising is viewed as a capital investment in goodwill, which has a cumulative effect on sales and

which depreciates over time. The probable factors causing a distributed lag in the effect of advertising in one period on the sales over a succession of periods are (Palda, 1965; Jastram, 1976):

(1) The type of advertising copy and the media used. Not all advertising and media choices by an advertising agency are designed to produce immediate purchases. Some are meant to build up favorable impressions upon which to capitalize later (a capital investment in goodwill).

(2) The germination period for a purchase decision. Several advertisements may be necessary before a buyer finally purchases. Even if potential customers are persuaded by an ad, they may not immediately be in the market for the product. The longer the germination period, the longer a specific advertising will take to show its result in increased sale.

(3) The marketing level where advertising is initiated. If a firm's advertising is aimed at ultimate consumers, while it sells in an intermediate market, an increased sales effect will be delayed in reaching the firm.

However reasonable the assumption of lagged effect, it gives us no clue as to the form (or time shape) of the distribution of the lags. The form of the lag structure depends on the duration (or longrun multiplier) and the shortrun time coefficients of the lag distribution. These characteristics empirically depend on the price policies, promotion policies, and competitive environment that are embodied in the product.

Because milk is advertised at both regional and national levels, the distributed lag formulation should apply to both regional and national advertising. We tested several lag structures, including gamma and polynomial distributed lags as the mechanism by which advertising influences sales. In the end, we adopted the 12-month, second-degree polynomial distributed lag used by Ward and Dixon (1989a) as the best choice. In their formulation, the log of current and lagged advertising for region i at time t, $Lnadver_{it}$, has the form:

$$Lnadver_{it} = \sum \{[\log(adverg_{i(t-j)} + advbrd_{(t-j)} + K)] * W_j\} \tag{7}$$

where adverg is deflated per capita regional radio and television milk advertising expenditures, advbrd is deflated per capita national television milk and 75-percent calcium advertising expenditures, and K is a goodwill constant of 0.0015. The W are weights based on a second-order polynomial of the form:

$$\delta_j = \alpha_0 + \alpha_1 \, (j+1)/13) + \alpha_2 \, (j+1)/13)^2 \tag{8}$$

Substituting the end points j = -1 and j = 12 in the above equation, one obtains the condition $\alpha_0 = 0$ and $\alpha_2 = -\alpha_1$, and

$$\delta_j = \alpha_1[(j+1)/13][(12-j)/13] \tag{9a}$$

or

$$\delta_j = \alpha_1 \, W_j \tag{9b}$$

The coefficient α_1 is the model estimate of advertising expenditure variable Lnadver. If we let j = 0,1,2,...11, the W's can be directly estimated to be:

$W_0 = W_{11} = .071007$; $W_1 = W_{10} = .130178$; $W_2 = W_9 = .177515$;
$W_3 = W_8 = .213018$; $W_4 = W_7 = .236686$; $W_5 = W_6 = .248521$.

Structural Change over Time

A major hypothesis of the fluid milk demand analysis is that changes in advertising expenditures have also led to structural changes in consumption habits. As stated by Jastram (1976), through a distributed lag formulation, each new advertising expenditure builds on the residual contributions of outlays in preceding periods. Thus, additional consumption generated over time may not be due to advertising expenditures in a single preceding period, but it may be the cumulative effect of advertising due to continuous increments of advertising outlays. The effect from a continuous increment of advertising outlay is also called the multiplier effect of advertising. After enough time and continuing advertising effort, the multiplier effect may change. Such a phenomenon may be due to increased advertising outlays and more efficient advertising or, conversely, decreased advertising outlays. Thus, the advertising coefficient may shift over time, representing a structural change in the multiplier effect. A shift in the advertising coefficient over time is the most direct effect, but the increased advertising activities may also have affected the coefficients of the other explanatory variables through change in consumption trends. In the Ward-Dixon model (1989a), structural change occurred every 12 months after the act in both the coefficients of weighted advertising expenditures and the time trend. In our updated version, the secondary effect of structural change in the time coefficient is hypothesized to occur only once in the postact period. The direct measure of structural change from advertising is the same as in previous analyses, which implies that the distributed advertising effects change their magnitudes every 12 months in the postact period, albeit with the same type of polynomial distribution.

Data

Our data encompass December 1978 through September 1991. The preact period is from December 1978 through August 1984. The postact period is from September 1984 through September 1991. The United Dairy Industry Association (UDIA), the California Milk Marketing Board, and the National Dairy Research and Promotion Board provided the regional consumption, income, advertising, and related deflators. The U.S. Department of Agriculture (USDA) provided regional prices. Without the effort of these organizations, we could not have estimated the model. To examine data movements in the pre- to postact periods, we calculated the 12-month averages of milk consumption, price, income, and advertising expenditures over the data observations. The 12-month period begins from September 1 of each year to August 31 of the following year.

Fluid Milk Consumption

Fluid milk consumption is recorded in terms of pounds of milk sold per month within each of the 12 regions. To account for the differences in population and in the number of days included in each month, milk sales are converted to average number of ounces consumed each day per capita. Ward and Dixon (1989b) showed that the monthly movement of per capita milk consumption generally demonstrates significant seasonal cycles with peaks in the early fall months and troughs in June. In terms of consumption trends, figure 1 shows that average per capita consumption for the 12 regions followed a negative trend through August 1984. In the subsequent periods from 1984 through 1987, per capita consumption tended to increase. Per capita consumption has since declined.

Fluid Milk Prices

Fluid milk prices from selected cities within the 12 regions are collected from the *Market Administrator Reports* by USDA's Agricultural Marketing Service (AMS). These prices, reported in units of cents per 1/2-gallon container, are deflated by using regional consumer price indexes (base = 1975). The 12-month average of real fluid milk price for the 12 regions declined consecutively from the beginning of the data period through September 1988 (fig. 2). Prices have since been slightly higher.

Income

Although average real income (1975 = 100) for the 12 regions increased over the period analyzed, the rate of increase was slower before than after passage of the act. During December 1978-August 1984, average

annual real income for the 12 regions increased by 2.38 percent (fig. 3). For September 1984-August 1991, average annual real income increased by 14.76 percent.

Fluid Milk Advertising

Advertising is measured in terms of expenditures per month. These expenditures take several forms depending on the controlling agent, the types of media used, and the message content. Before the start of the National Dairy Board (NDB) programs in September 1984, all fluid milk advertising was the responsibility of separate regional organizations. With the establishment of the NDB, a checkoff from dairy farmers of 15 cents per hundredweight of commercially produced milk has funded the NDB promotional programs. Ten cents of the checkoff reverts to qualified regional programs, while the remaining 5 cents goes to the Board for national research, promotion, and educational programs. Since September 1984, generic fluid milk advertising has included both regional and national promotional expenditures. These expenditures include regional radio and television advertising and national fluid milk and calcium advertising. On advice from the NDB staff, 75 percent of calcium advertising has been added to fluid milk advertising. Thus, per capita real advertising expenditures included per capita regional radio and television expenditures before September 1984, with per capita national television advertising and 75 percent of national calcium advertising added to the regional data after September 1984.

The deflated average per capita media expenditures during 1978-91 are illustrated in figure 4. There were substantial increases in the advertising expenditures in the early months following passage of the promotion act. The 12-month average of per capita real advertising expenditures increased from $0.04 in August 1984 to $0.06 in August 1986, a 50-percent increase. In recent years, the deflated per capita advertising expenditures have declined to almost the preact level.

Demographic Variables

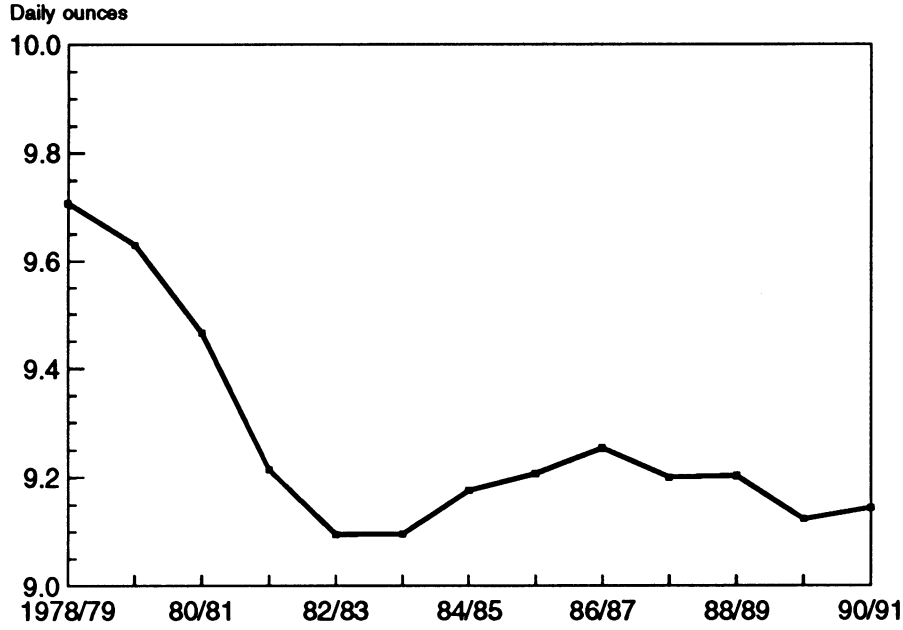
The demographic variables that are used to account for different noneconomic characteristics in the various regions include (a) the percentage of a region's population that is under 18 years of age; (b) the percentage that is female; (c) the percentage that is black; (d) the percentage that is rural; (e) the percentage of households that contain only one person; and (f) the median number of years of schooling among people over 25 years of age. The monthly observations were generated by interpolation and extrapolation of Bureau of the Census data, which provide demographic information for all six variables on a county basis.

We estimate the per capita demand for fluid milk as a function of income, prices, seasonality, advertising, and demographics:

$$\begin{aligned} Lnpcads_{it} = {} & B_0 + B_1\, Lnmapr_{it} + B_2\, Lndpcin_{it} + B_3\, Lnnu18_{it} \\ & + B_4\, Lnfem_{it} + B_5\, Lnblk_{it} + B_6\, Lnrur_{it} + B_7\, Lnhous_{it} \\ & + B_8\, Lnschl_{it} + B_9\, Lnadver_{it} + B_{10}\, Adv1_{it} + B_{11}\, Adv2_{it} \\ & + B_{12}\, Adv3_{it} + B_{13}\, Adv4_{it} + B_{14}\, Adv5_{it} + B_{15}\, Adv6_{it} \\ & + B_{16}\, Adv7_{it} + B_{17}\, Lntime_{it} + B_{18}\, Ta1_{it} + B_{19}\, Djan_{it} \\ & + B_{20}\, Dfeb_{it} + B_{21}\, Dmar_{it} + B_{22}\, Dapr_{it} + B_{23}\, Dmay_{it} \\ & + B_{24}\, Djun_{it} + B_{25}\, Djly_{it} + B_{26}\, Daug_{it} + B_{27}\, Dsep_{it} \\ & + B_{28}\, Doct_{it} + B_{29}\, Dnov_{it} + e_{it} \end{aligned} \tag{10}$$

Figure 1

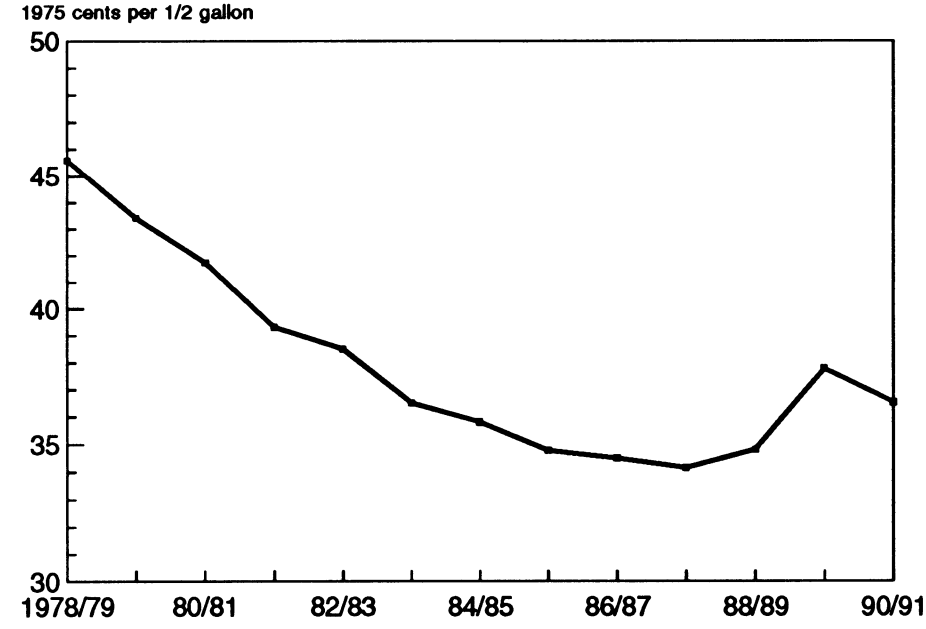
Average per capita fluid milk consumption 1/



1/ Average of 12 regions. First period=12/78-8/79. Remaining periods are September 1 to August 31 of the following year.

Figure 2

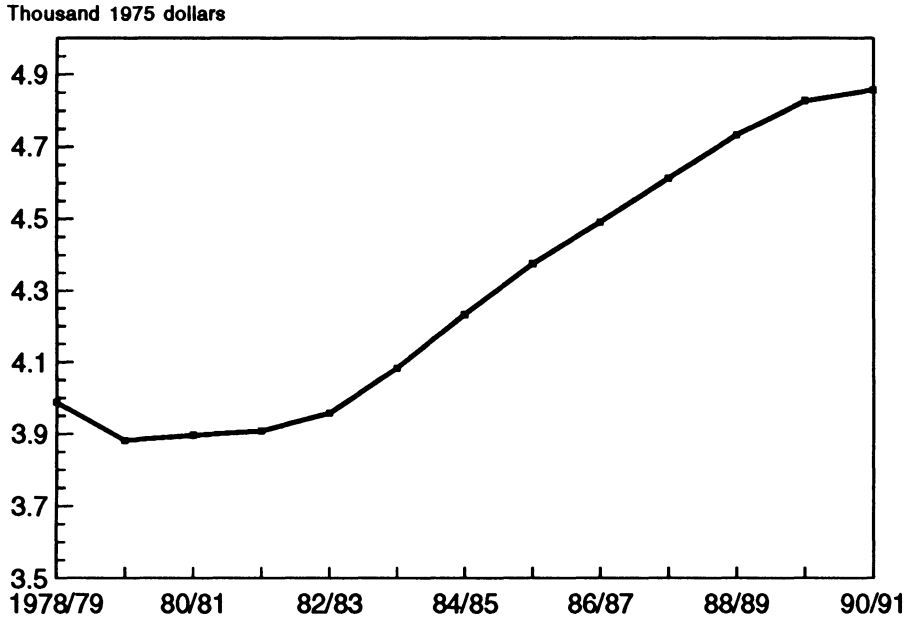
Average fluid milk price 1/



1/ Average of 12 regions. First period=12/78-8/79. Remaining periods are September 1 to August 31 of the following year.

Figure 3

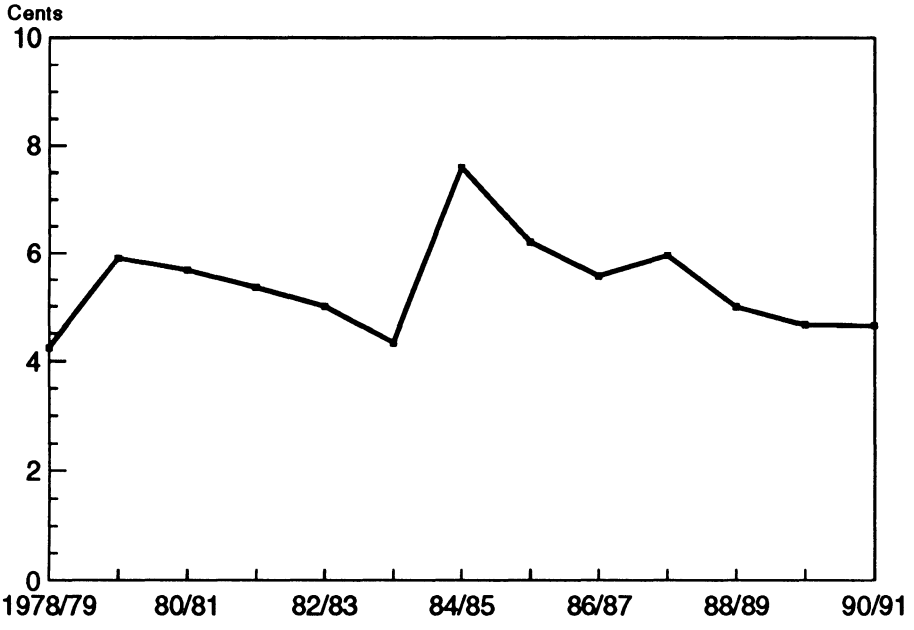
Average per capita income 1/



1/ Average of 12 regions. First period=12/78-8/79. Remaining periods are September 1 to August 31 of the following year.

Figure 4

Deflated per capita advertising expenditures 1/



1/ Average of deflated regional and nationally prorated expenditures in 12 regions. First period is 12/78-8/79. Remaining periods are September 1 to August 31 of the following year.

where

Lnpcads	=	Log of the average daily ounces consumed per capita by region.
Lnmapr	=	Log of the deflated fluid milk price per half gallon with price reported by the market administrator for selected U.S. cities.
Lndpcin	=	Log of deflated per capita income across regions and over time.
Lnnu18	=	Log of the percentage of a region's population under 18 years of age.
Lnfem	=	Log of the percentage of a region's population that is female.
Lnblk	=	Log of the percentage of a region's population that is black.
Lnrur	=	Log of the percentage of a region's population that lives in rural areas within each region.
Lnhous	=	Log of the percentage of a region's households that are single member families.
Lnschl	=	Log of the median number of years of education for individuals over 25 years of age.
Lnadver	=	The advertising variable expressed as a restricted polynomial lagged model with advertising measured in real per capita advertising expenditures.
Adv1	=	Lnadver*T1, and T1 = 1 for September 1984 through July 1985.
Adv2	=	Lnadver*T2, and T2 = 1 for August 1985 through September 1986.
Adv3	=	Lnadver*T3, and T3 = 1 for October 1986 through September 1987.
Adv4	=	Lnadver*T4, and T4 = 1 for October 1987 through September 1988.
Adv5	=	Lnadver*T5, and T5 = 1 for October 1988 through September 1989.
Adv6	=	Lnadver*T6, and T6 = 1 for October 1989 through September 1990.
Adv7	=	Lnadver*T7, and T7 = 1 for October 1990 through September 1991.
Lntime	=	Log of the variable Time (Time = 48-201 for December 1978 through September 1991).
Ta1	=	Lntime*Ta, and Ta = 1 for September 1984 through September 1991.
Djan	=	Seasonal dummy variable for January.
Dfeb	=	Seasonal dummy variable for February.
Dmar	=	Seasonal dummy variable for March.
Dapr	=	Seasonal dummy variable for April.
Dmay	=	Seasonal dummy variable for May.
Djun	=	Seasonal dummy variable for June.
Djly	=	Seasonal dummy variable for July.
Daug	=	Seasonal dummy variable for August.
Dsep	=	Seasonal dummy variable for September.
Doct	=	Seasonal dummy variable for October.
Dnov	=	Seasonal dummy variable for November.
e_{it}	=	Equation error for region i (i = 1-12) and time t (t = 48-201).

Estimation and Empirical Results

The pooled time-series cross-sectional econometric model for fluid milk sales is specified in a log-linear form. Because of the distributed lag advertising assumption, the error term in each cross section is assumed to be characterized by first-order autocorrelation. Because the same economic forces affect all regions, contemporaneous errors across the regions are also assumed to be correlated. Parks' method for the generalized least squares procedure is used in the estimation (Parks, 1967). Table 1 provides the estimation results.

Interpretation of Results

Fluid milk price and income elasticities have the expected signs and are statistically significant at the 99-percent confidence level. The price elasticity, -0.15, is about the same as that estimated by Ward and Dixon (1989b). Income elasticity is 0.25, slightly lower than that obtained by Ward and Dixon. The seasonality parameters are consistent with most other milk demand studies, which imply declining consumption in the summer months and increases in the winter months.

Of the demographic effects, younger consumers and women are expected to have a stronger demand for dairy products because of calcium requirements. On the other hand, studies show that blacks have a higher

Table 1--Summary of fluid milk model estimates (December 1987-September 1991)[1]

Variable	Coefficient	Standard error	T-test
Intercept	5.055363	0.303135	16.676915
Lnmapr	-.146289	.016310	-8.969515
Lndpcin	.248839	.024252	10.260539
Lnnu18	.637327	.040435	15.761738
Lnfem	2.169975	.279367	7.767479
Lnblk	-.098182	.002291	-42.859129
Lnrur	-.013925	.003907	-3.564421
Lnhous	.382778	.035299	10.844001
Lnschl	-.537898	.081164	-6.627266
Lnadver	.012410	.002678	4.633242
Adv1	.020161	.005040	4.000058
Adv2	.019588	.005207	3.761985
Adv3	.017915	.005200	3.444896
Adv4	.017177	.005291	3.246334
Adv5	.016506	.005392	3.061127
Adv6	.014939	.005426	2.753178
Adv7	.014231	.005467	2.603140
Lntime	-.068677	.017805	-3.857230
TA1	.047902	.012039	3.979035
Djan	.025689	.003748	6.854866
Dfeb	.026182	.004858	5.389261
Dmar	.030886	.005480	5.636340
Dapr	.011059	.005852	1.889861
Dmay	-.010882	.006063	-1.794757
Djun	-.059648	.006156	-9.689210
Djly	-.070439	.006141	-11.470205
Daug	-.035459	.006003	-5.906831
Dsep	.027054	.005626	4.808619
Doct	.032987	.004990	6.610605
Dnov	.023628	.003873	6.100261

Estimated values of rho:

Cal	0.8055	Mic	0.7701
Col	.5511	Eng	.8099
Fla	.6718	Alt	.7811
Gbs	.5705	Tex	.6594
Geo	.7690	Umw	.7259
Kan	.7291	Vir	.8465

No. of cross sections = 12
No. of time series = 154
Total observations = 1,848

R^2	MSE	PRMSE	MABSER
0.9003	0.0023	2.2035	0.0194

[1]See appendix for list of regions.

level of intolerance to lactose (Goodhart and Shils, 1980); thus, a negative effect is expected for blacks. Rural consumers may have alternative supply sources other than commercial channels, which may also have negative effects on commercial sales. The estimated coefficients of these variables confirm these hypotheses. A 1-percent increase in the proportion of females in the population increases milk consumption by 2.2 percent. A 1-percent increase in the proportion of younger consumers in the population increases milk consumption by 0.64 percent. Milk consumption is clearly lower among blacks and rural groups. A 1-percent increase in the proportion of either of these groups reduces total milk consumption by 0.01 to 0.1 percent.

The expected effects of family size and schooling are ambiguous. Larger sized families may view milk as a low-cost protein source and may use it more often because these families usually contain young children. On

the other hand, single-person households may view milk as a convenience food and may consume more of it than larger households on a per person basis. Education may increase nutritional awareness, and thus milk consumption. However, education may be linked to a concern about fat, thus lowering consumption levels among more educated consumers. The estimated coefficients indicate that single-family size has a positive coefficient of 0.38, and schooling a negative coefficient of -0.53. In comparison with Ward and Dixon (1989b), all of the social-demographic coefficients agree in signs. Their magnitudes have been reduced, however, except for the black and female variables.

Because the advertising variable, lnadver, in the equation represents a 12-month weighted sum of current and lagged per capita advertising expenditures, the coefficient of this variable, 0.0124, reflects an average effect for the 12-month cumulative advertising expenditures (the α_1 in equation (9b)). The advertising coefficients for adv1 (0.0202) through adv7 (0.0142) measure changes in the average advertising effect following passage of the act. Because advertising expenditures were larger immediately after enactment of the act (fig. 4), the advertising effect was largest during September 1984 through July 1985, 0.032 (average coefficient + the first shift coefficient). The advertising effect tapers off thereafter at each time interval until the postact effect declines to 0.026 (average coefficient + the last shift coefficient).

To examine the distribution of advertising effects, we have graphed selected shortrun lagged advertising coefficients, and the longrun pre- and postact cumulative advertising effects (advertising multipliers) in figures 5 and 6. In figure 5, the current and lagged shortrun advertising coefficients are graphed for three different time periods: the preact period (December 1978 through August 1984), the immediate postact period (September 1984 through July 1985), and the most recent period (October 1990 through September 1991). For all periods, the shortrun advertising effects demonstrate a peak after 6 months. However, the level and rate of change (the time shape) that the shortrun advertising coefficients traced are different for the different time intervals. The time-shape of the lagged effects is flatter in the preact period than in the postact periods, indicating that advertising effects were smaller before the passage of the act. The largest shortrun advertising effects are registered in the months immediately following the passage of the act. In other words, higher advertising expenditures in the immediate postact period increased both current and lagged advertising effects, but such phenomena have changed in recent years, as evidenced from the second curve in figure 5.

To find the total advertising effect for each period, we use the multipliers of advertising. In figure 6, the multiplier effect indicates that a 10-percent increase in advertising expenditures would eventually increase consumption by 2.6 percent in the preact period. In the first time-interval of the postact period, a 10-percent increase in advertising expenditures would eventually increase consumption by 7 percent. However, the cumulative advertising effect has declined monotonically ever since. During the period between August 1990 and September 1991, a 10-percent increase in advertising expenditures would induce less than a 6-percent increase in consumption.

Milk consumption has a distinctly declining trend during the preact period. The coefficient of the time trend variable for this period is -0.068. The coefficient for the time trend variable in the postact period is 0.048. Ward and Dixon (1989b) hypothesized that increased awareness of the importance of calcium in the diet may lead to changes in consumption habits that are captured through the time trend.

Simulation of Fluid Milk Advertising Effects

Analysis of the simulation effects of advertising on fluid milk consumption includes two parts: examining the influence of advertising under different scenarios of advertising expenditures and examining marginal changes in advertising effects.

Figure 5
Distribution of advertising effects for fluid milk

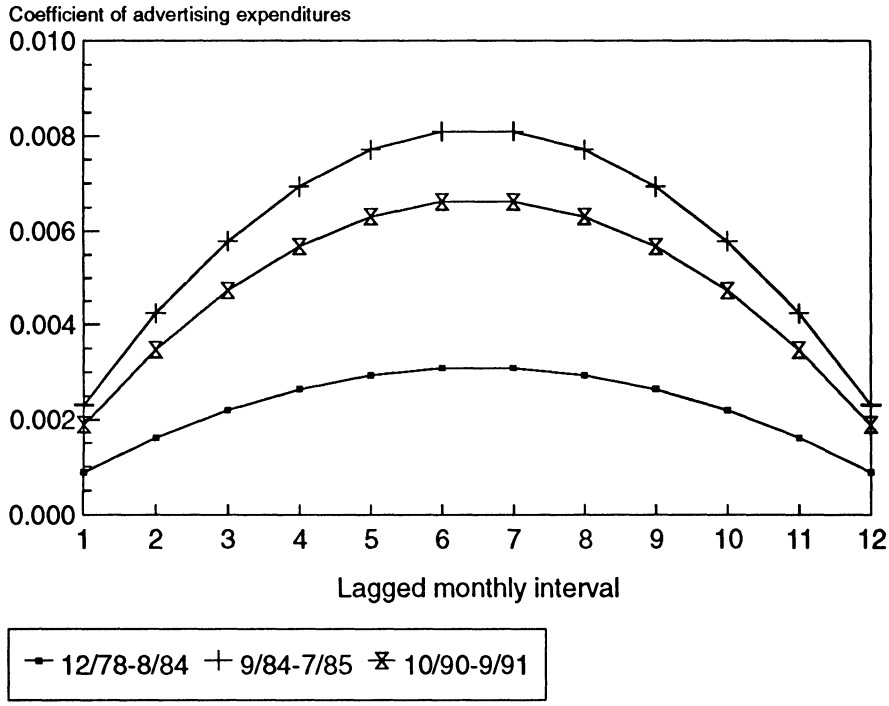
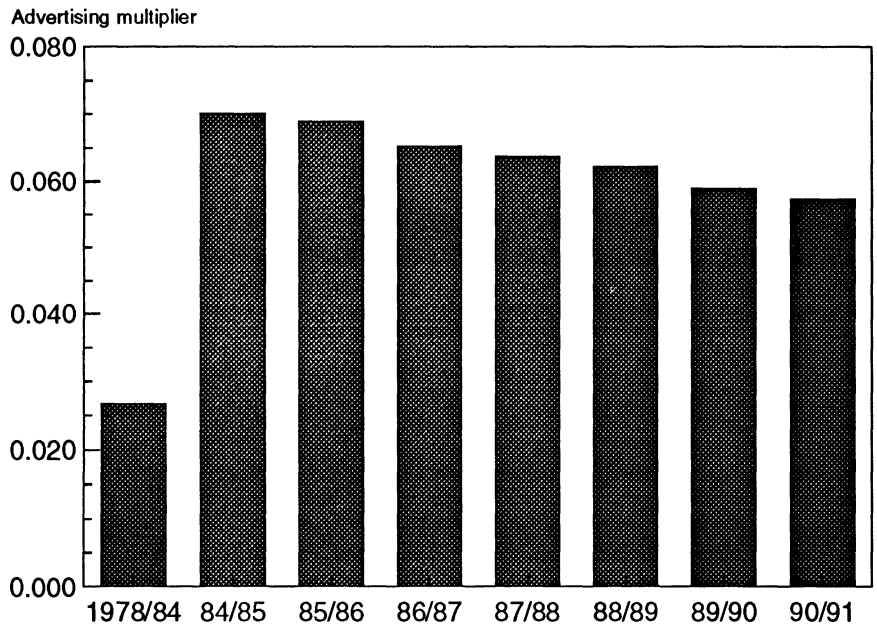


Figure 6
Dynamic shifts of advertising multiplier for fluid milk 1/



1/ Time intervals same as in figure 5. Advertising multiplier = total of current and lagged advertising effects for indicated time interval.

Gains from Advertising under Different Scenarios

We simulated three types of advertising effects on the consumption of fluid milk:

(1) Gains due to advertising. The gains are computed by simulating sales with and without advertising and reporting the difference.

(2) Gains due to the act. First, we assumed that regional advertising expenditures remained at the preact September 1983-August 1984 level (undeflated yearly total of about $18.5 million for the 12 regions). We then compared simulated sales under this advertising scenario with sales simulated from the model using actual data. The difference is the gain in sales from the act, assuming that regional programs would have continued to advertise at preact levels. In the Ward and Dixon simulations (1989b), per capita advertising expenditures are deflated with a postact deflator. In our estimations, per capita advertising expenditures are deflated with a preact deflator. Thus, we assume real per capita advertising expenditure levels in the postact period are identical to those in the immediate preact period, while Ward and Dixon's simulations assume that real advertising levels would have declined.

(3) Gains due to structural changes after the national program went into effect. The structural changes are measured through both the dynamics of the advertising multipliers and cyclical consumption changes in the postact period.

Tables 2 and 3 provide the fluid milk advertising expenditures and the bootstrap simulation results for the three scenarios of advertising and structural effects on fluid milk sales. In table 2, the time intervals are divided into the pre- and postact periods as shown in column 1. Columns 2 and 5 give total expenditures for the regions and the NDB. Column 3 is the NDB expenditures prorated to the 12 regions. Column 4 shows the total of regional and prorated national advertising efforts for the 12 regions. Total equivalent fluid milk advertising in the postact months equaled about $178.5 million in the 12 regions.

Table 2--Generic advertising expenditures for fluid milk

Monthly intervals (1)	Regional programs (2)	National prorated (3)	Total regions (4)	Total national (5)
		Dollars		
Preact:				
December 1978-August 1979	8,814,681	0	8,814,681	0
September 1979-August 1980	13,380,032	0	13,380,032	0
September 1980-August 1981	14,769,237	0	14,769,237	0
September 1981-August 1982	16,267,178	0	16,267,178	0
September 1982-August 1983	18,664,497	0	18,664,497	0
September 1983-August 1984	18,547,223	0	18,547,223	0
December 1978-August 1984	90,442,848	0	90,442,848	0
Postact:				
September 1984-August 1985	18,583,198	11,403,812	29,987,010	27,553,015
September 1985-August 1986	12,820,909	10,661,764	23,482,673	25,658,104
September 1986-August 1987	11,229,605	10,535,187	21,764,792	25,281,812
September 1987-August 1988	14,921,175	12,668,785	27,589,960	30,195,400
September 1988-August 1989	16,056,224	8,912,924	24,969,148	21,102,400
September 1989-August 1990	15,591,570	7,660,962	23,252,532	18,155,425
September 1990-August 1991	16,735,898	8,152,273	24,888,171	19,131,375
September 1991	2,098,290	475,559	2,573,849	1,112,650
September 1984-September 1991	108,036,869	70,471,266	178,508,135	168,190,181
December 1978-September 1991	198,479,717	70,471,266	268,950,983	168,190,181

Table 3--Actual fluid milk sales and simulated sales gains from generic advertising

Monthly intervals	Fluid milk sales		Advertising gains			Gain due to—	
	Actual	Estimated	Total advertising	Postact advertising[1]	Structural change	Total advertising	Postact advertising[1]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Millions pounds					*Percent*	
Preact:							
December 1978-August 1979	16,321.2	16,057.1	577.6	0	0	3.54	0
September 1979-August 1980	21,861.6	21,340.3	782.1	0	0	3.58	0
September 1980-August 1981	21,754.7	21,163.0	729.1	0	0	3.35	0
September 1981-August 1982	21,411.6	21,099.9	716.5	0	0	3.35	0
September 1982-August 1983	21,431.1	20,976.6	693.8	0	0	3.24	0
September 1983-August 1984	21,808.5	21,246.1	680.0	0	0	3.12	0
September 1978-August 1984	124,588.7	121,883.0	4,179.1	0	0	3.35	0
Postact:							
September 1984-August 1985	22,152.1	21,675.1	2,137.8	419.6	302.4	9.65	1.89
September 1985-August 1986	22,406.4	22,068.2	2,461.4	739.3	647.3	10.99	3.30
September 1986-August 1987	22,619.0	22,149.1	2,477.1	750.1	886.5	10.95	3.32
September 1987-August 1988	22,944.9	22,711.7	2,807.4	1,061.2	1,242.7	12.24	4.62
September 1988-August 1989	23,340.6	22,810.2	2,998.7	1,262.8	1,522.1	12.85	5.41
September 1989-August 1990	23,531.7	22,895.2	3,190.1	1,464.9	1,852.2	13.56	6.23
September 1990-August 1991	23,680.9	22,881.1	3,331.0	1,620.9	2,104.1	14.07	6.84
September 1991	1,976.5	1,903.3	280.4	136.6	180.5	14.19	6.91
September 1984-September 1991	160,675.6	159,093.9	19,683.9	7,455.4	8,737.8	12.25	4.64
December 1978-September 1991	285,264.3	280,976.9	23,863.0	7,455.4	8,737.8	8.37	2.61

[1]Gains measured when advertising expenditures were fixed at September 1983-August 1984 regional levels.

In table 3, the time intervals correspond to column 1 of table 2. Column 2 shows actual sales, and column 3 shows predicted sales using the observed data. Columns 4, 5, and 6 report the gains due to advertising under the three different scenarios. Columns 7 and 8 show the gains in columns 4 and 5 as percentages of actual sales (column 2).

Column 4 represents gains in sales with advertising as opposed to sales without advertising. The results indicate that gains in fluid milk sales due to advertising for December 1978 through August 1984 were about 4.2 billion pounds (about 60.5 million pounds per month). The postact gains reached 19.7 billion pounds (about 231.5 million pounds per month).

Column 5 in table 3 presents the simulated sales gains (of 7.45 billion pounds) due to the act. If yearly advertising expenditures stayed at the preact level of $18.5 million, the increased expenditures for the postact period would be about $131.4 million. The difference between the actual expenditures and the hypothesized expenditures is $47.1 million. With the gains due to the act, 7.45 billion pounds, the gain per advertising dollar is about 158 pounds. The estimated sales gain is about 4.6 percent of total sales.

Column 6 of table 3 is the simulated structural change due to advertising and the accompanying changes caused by shifts in consumption trends. The total effect of the structural changes in the postact periods is an 8.7-billion-pound consumption increase. Because the cumulative effects of advertising decline over the postact period as a result of declining per capita advertising expenditures, structural changes measured by advertising shifts also decline in recent periods. On the other hand, the secondary structural change measured by the time coefficient is large for the total postact period. Thus, total structural change measured from both time and advertising shift coefficients (column 6) is larger than the pure total advertising effects (column 5).

Marginal Advertising Changes

Marginal advertising changes measure how different rates of advertising expenditures affect fluid milk sales. To study the marginal gains from advertising in the postact period, simulations are performed with 10 different levels of advertising expenditures. These different advertising levels are calculated as percentage decreases and increases from actual advertising expenditures during the postact period ($178.5 million). Table 4 provides the simulated total sales for the different advertising expenditure levels and the corresponding marginal changes at these expenditure levels. A 20-percent reduction of the actual expenditures would have a marginal gain of 49 pounds per dollar, while a 20-percent increase from the actual expenditure level would increase sales by marginal gain at a decreasing rate of 36.7 pounds per dollar. The change in marginal sales from 80 percent to 120 percent of the actual advertising expenditures is a decrease of marginal gains of 12 pounds per dollar.

Table 4--Estimated marginal fluid milk gains at different advertising levels

Percent change in advertising expenditure (1)	Advertising expenditures in sales (2)	Estimated sales (3)	Marginal changes (4)	Pounds per dollar (5)
Percent	*Million dollars*	*Billion pounds*	*Million pounds*	*Pounds/ dollar*
80	142.81	157.43339	438.12	49.09
85	151.73	157.85358	420.19	47.08
90	160.66	158.25734	403.76	45.24
95	169.58	158.64597	388.63	43.54
100	178.51	159.02061	374.64	41.97
105	187.43	159.38228	361.67	40.52
110	196.36	159.73191	349.63	39.17
115	205.28	160.07030	338.39	37.91
120	214.21	160.39819	327.89	36.74

Simulation of Fluid Milk Price and Income Effects

Table 5 presents simulations of consumption changes when price or income is assumed to remain at the preact September 1983-August 1984 level. The per capita real fluid milk price during September 1983-August 1984 was 36.5 cents per pound. It decreased to 34.2 cents per pound during 1987/88, and rose to 36.5 cents per pound during 1990/91. Declining price caused consumption to increase in the postact period. Column 4 of table 5 indicates the simulated total gain from price decreases in the postact period is 945.5 million pounds, about 0.6 percent of the actual sales from September 1984 to September 1991.

Per capita real income in the postact period increased 19 percent from September 1983 to August 1984. Column 5 of table 5 indicates a simulated increase of 3,286 million pounds, or 2.0 percent of actual sales, as a result of increased income.

Specification of the Cheese Models

Branded and generic advertising, price of cheese, prices of substitutes (such as meat, poultry, and fish), income, seasonality, trends, and government donations influence the demand for cheese. To isolate and measure the effects of advertising, we must control for the effects of these variables on quantities demanded. Processed and natural cheese purchase patterns, prices, and product characteristics are sufficiently different to warrant separate analyses of each. Among these differences are the following:

(1) Natural cheese purchases vary significantly by month and season, with a peak in December and a trough in July. Processed cheese purchases vary much less from season to season.

(2) Government donations of cheese under the Temporary Emergency Food Assistance Program were predominantly processed cheese. Hence, donations probably have a greater effect on processed cheese purchases than on purchases of natural cheese.

(3) Natural cheese is a higher priced product than processed cheese. Hence, it should have larger price and income effects.

As with the fluid milk model, advertising expenditures are assumed to have carryover effects. Unlike the milk model, the cheese advertising variable (both generic and branded) is modeled in an inverse functional form with its carryover effects following a gamma distribution. Generic and branded advertising expenditures were entered separately in the natural cheese equation. A single company usually dominated advertising expenditures for processed cheese, and a high percentage of these promotion expenditures were for just a few products (*Leading National Advertisers*). Thus, for processed cheese, branded advertising may have generic advertising characteristics, and they are entered as a single variable in the processed cheese model.

Because we are interested in examining the entry and exit effects of advertising in the consumer demand for cheese, we estimated three demand equations for each type of cheese. These equations are the market demand for cheese, the average quantity demanded, and demand in terms of the proportion of purchasing consumers in the market. Aside from advertising expenditures, seasonal dummies, and a trend term, other variables are in logarithmic form. The two sets of mathematical demand equations, for natural and processed cheese, are as follows:

Table 5--Simulated gains in fluid milk sales attributed to price and income changes after passage of the act

Monthly intervals	Fluid milk sales		Price and income gains		Gains due to--	
	Actual	Estimated	Price fixed[1]	Income fixed[1]	Price	Income
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Million pounds				*Percent*	
September 1984-August 1985	22,152.1	21,700.4	59.8	206.7	0.27	0.93
September 1985-August 1986	22,406.4	22,072.2	162.6	322.0	.73	1.44
September 1986-August 1987	22,619.0	22,169.8	197.0	410.1	.87	1.81
September 1987-August 1988	22,944.9	22,710.7	258.0	512.4	1.12	2.23
September 1988-August 1989	23,340.6	22,794.5	199.0	587.6	.85	2.52
September 1989-August 1990	23,531.7	22,916.4	-35.2	632.8	-.15	2.69
September 1990-August 1991	23,680.9	22,816.6	82.0	560.3	.35	2.37
September 1991	1,976.5	1,898.4	22.3	53.8	1.13	2.72
September 1984-September 1991	160,675.6	159,079.0	945.5	3,285.7	.59	2.04
December 1978-September 1991	285,264.3	281,069.5	945.5	3,285.7	.33	1.15

[1]Gains measured when price or income were fixed at September 1983-August 1984 level.

$$LnQ_t^n,\ Lnq_t^n,\ LnP_r^n = \beta_0 + \beta_1\ LnP_t^n + \beta_2\ LnP_t^p + \beta_3\ LnP_t^m + \beta_4\ D_t + \beta_5\ LnY_t + \beta_6\ T_t + \sum_{j=1}^{11} d_j\ M_j + \alpha_1 \sum_{i=0}^{t-1} (i+1)^{c/1-c)}\ L^i[1/(K_1 + A_{t-i}^g)] + \alpha_2 \sum_{i=0}^{t-1} (i+1)^{s/(1-s)}\ H^i[Ln(K_2 + A_{t-i}^b)] + e_t \quad (11)$$

and

$$LnQ_t^p,\ Lnq_t^p,\ LnP_r^p = \beta_0 + \beta_1\ LnP_t^p + \beta_2\ LnP_t^n + \beta_3\ LnP_t^l + \beta_4\ LnP_t^m + \beta_5\ LnY_t + \beta_6\ LnD_t + \alpha_1 \sum_{i=0}^{t-1} (i+1)^{g/(1-g)}\ G^i[1/(K_1 + Adv_{t-i})] + e_t \quad (12)$$

where:

LnQ_t^n = Log of per capita quantity of natural cheese purchases by U.S. households, in pounds per month t, (t = 1...124 for January 1982 through June 1991).

Lnq_t^n = Log of average per capita quantity of natural cheese purchases by U.S. households purchasing natural cheese, in pounds per month t (t = 1...124 for January 1982 through June 1991).

LnP_r^n = Log of proportion of all U.S. households that purchased natural cheese during month t (t = 1...124 for January 1982 through June l991).

LnQ_t^p = Log of per capita quantity of processed cheese purchases by U.S. households, in pounds per month t, (t = 1...124 for January 1982 through June 1991).

Lnq_t^p = Log of average per capita quantity of processed cheese purchases by U.S. households purchasing natural cheese, in pounds per month t (t = 1...124 for January 1982 through June 1991).

LnP_r^p = Log of proportion of all U.S. households that purchased processed cheese during month t (t = 1...124 for January 1982 through June l991).

LnP_t^n = Log of price of natural cheese in dollars per pound, deflated by the Consumer Price Index (CPI, 1977 = 100) for all urban consumers.

LnP_t^p = Log of price of processed cheese in dollars per pound, deflated by the CPI.

LnP_t^m = Log of price index for meat, poultry, and fish, deflated by the CPI.

LnP_t^l = Log of price of imitation cheese in dollars per pound, deflated by the CPI.

LnY_t = Log of U.S. per capita disposable income in period t, deflated by the CPI.

LnD_t = Log of per capita domestic donations of cheese in pounds under the Temporary Emergency Food Assistance Program.

T_t = Time trend, T = 1...124 for January 1982 through June 1991.

M_j = Monthly dummy variables, M_1 = 1 if j = January, zero otherwise, M_2 = 1 if j = February, zero otherwise, and so forth. December is omitted to avoid perfect multicollinearity.

A_{t-i}^g = Current and past per capita generic advertising expenditures for cheese deflated by media cost index (i = 0 for the current period and i = t-1 for the beginning period).

A_{t-i}^b = Current and past per capita branded advertising expenditures for cheese deflated by media cost index (i = 0 for current period and i = t-1 for the beginning period).

Adv_{t-i} = Deflated current and past per capita advertising expenditures (branded and generic) for processed cheese (i = 0 for current period and i = t-1 for beginning period).

K_1, K_2 = Goodwill indexes for generic and branded cheese advertising. This value is small (0.0001), intended to capture the word-of-mouth or other goodwill effect at any given time even if no advertising took place.

The weights $(i+1)^{c/(1-c)}\ L^i$ and $(i+1)^{s/(1-s)}\ h^i$ in equation (11) represent gamma lag structures for the inverse of current and past per capita (deflated) generic advertising expenditures, and logarithm of per capita branded

advertising expenditures. The time shapes of these gamma lags are determined by parameters c, L, s, and H. The gamma lag structure for the inverse of both generic and branded advertising expenditures and goodwill in equation (12) is $(i+1)^{g/(1-g)}\, G^i$. The time shapes of these gamma lags are determined by parameters g and G.

Time-Varying Parameter Estimation

As with the fluid milk model, advertising in the cheese model is hypothesized to have carryover effects and the time shape of the carryover effect changes over time. Such change in the advertising multiplier effect is because, as the public continues to see and read cheese advertisements, the quality of the ad changes, or the overall advertising strategy is refined. By allowing the advertising parameter to change over time, the model hypothesizes that there is a dynamic relationship between advertising and sales. In the fluid milk demand model, such dynamic aspects of advertising are captured through the estimates of the interaction of weighted advertising expenditures and time. In the cheese model, the time-varying parameter models (tvpm) procedure tests this dynamic multiplier effect. The tvpm estimation procedure of the cheese model specifically allows the coefficients of advertising to have a time-varying process in the form of a random walk. In other words, let the advertising coefficients be $\alpha_t = \alpha_{t-1} + \upsilon_t$. With this specification, parameter α_t will drift over the course of the data, usually with an obvious trend reflecting continuing change of the parameter if it does change over the sample period.

Because of the carryover and time-varying advertising parameter assumptions, the error terms of the equations are assumed to follow a first-order autocorrelation scheme. Direct estimation of the parameters of the gamma distribution is not practical. The estimation strategy was to set the parameters to fixed values and to estimate the remaining parameters in a given equation by ordinary least squares. The procedure was repeated for a wide range of values for c, L, s, H, g, and G, and the equation yielding the best statistical fit with plausible parameter estimates was selected. Thus, the standard errors for the parameters c, L, s, H, g, and G are not available. This estimation procedure will also bias downward the standard errors of other parameters in the model.

Data

Data on retail prices and quantities for natural, imitation, and processed cheese are obtained from the National Dairy Board as reported by the Market Research Corporation of America (MRCA). The time-series data on household cheese purchases reflect aggregate national purchase data estimated from a continuing consumer panel survey. The data include only cheese purchased for direct consumption at home. Cheese consumed in restaurants, away-from-home establishments, or consumed in connection with purchased foods (such as pizzas and macaroni-and-cheese mixtures) are not included.

Because the MRCA prices and quantities are reported in 4-week intervals, these data have to be converted to a calendar-month basis. The method was to allocate to each month the prices or quantities in a week that overlapped 2 calendar months according to the number of days in the overlapping months. Total number of buying households in a month is divided by the total number of households to calculate the proportion of buying households in a given month. To remove any artificial month-to-month fluctuations caused strictly by the uneven number of days in a month, data for quantity, income, and advertising expenditures are also adjusted for each calendar month to reflect the same number of days.

The Bureau of Labor Statistics (BLS) provided the price indexes for meat, poultry, and fish and the CPI for all items. Personal disposable income is obtained from the Bureau of Economic Analysis, U.S. Department of Commerce. U.S. civilian population data are from the Bureau of the Census, U.S. Department of Commerce.

Government cheese donations are expected to displace retail sales. A time trend is assumed to capture the downward trend in natural cheese consumption. Monthly dummy variables in the natural cheese model capture seasonal variation in consumption.

Monthly branded cheese advertising expenditures were supplied by UDIA. UDIA, together with NDB, Wisconsin Milk Marketing Board, and the California Milk Advisory Board, supplied monthly cheese generic

promotion expenditures. Twenty-five percent of NDB's calcium advertising expenditures were included in the advertising variable. One should be cautioned that promotion expenditures represent only the media cost component of advertising. Promotion expenditures do not include such items as talent and production costs.

Table 6 provides generic and branded cheese advertising expenditures for 1982-91. Generic advertising peaked in 1985 at $58 million, and declined to $37.3 million in 1990. Still, the increase from 1982 to 1990 is over 543 percent. Branded advertising expenditures fluctuated between 1982 and 1987, then increased steadily to $104 million in 1990. The increase from 1989 to 1990 is about 21.2 percent. Media expenditures include radio, television, outdoor, and print costs.

Separate media cost indexes deflated both generic and branded advertising expenditures, allowing advertising expenditures to be interpreted as a measure of the quantity of advertising taking place in each time period. We constructed the divisia advertising cost indexes using information on the share of total advertising expenditures spent for each type of media and price indexes for each media type. Divisia cost indexes are exact for an underlying translogarithmic unit cost function. (For details in constructing this type of index, see Diewert, 1976, p. 121.) Monthly advertising expenditures by media type (for both branded and generic advertising) and monthly price indexes by media type were not available. Thus, we constructed quarterly divisia indexes. We obtained the budget shares devoted to each media type for cheese advertising by quarter from various issues of *Leading National Advertisers* (*LNA*). In the case of generic advertising, some judgments were required in constructing media shares because *LNA* did not always separate UDIA advertising expenditures for cheese from other dairy products. Yearly media price indexes by media type were taken from *Media Insights*, published by the advertising firm of D'Arcy, MacManus, and Masuis. We used that firm's adjustment factors to convert the yearly price indexes to a quarterly basis.

Empirical Results of the Market Demand for Cheese

Tables 7 and 8 present parameter estimates of the natural and processed cheese market demand equations. Although both equations were tested with the dynamic advertising multiplier hypothesis, the time-varying parameter estimations yielded almost constant coefficients over time for the advertising variables in each equation. Thus, the results are of a fixed parameter estimation with the assumption of first-order autocorrelation. Both equations provide a reasonably good statistical fit to the data. Most parameter estimates have the expected signs and are generally of reasonable magnitudes.

Demand is more elastic for natural than for processed cheese. In the market demand equations, the own-price elasticity for natural cheese is about -1.5, and that for processed cheese about -0.79. Thus, a 10-percent decrease in the price of natural cheese would increase consumption by 15 percent. On the other

Table 6--Estimated generic and branded cheese advertising expenditures

Period	Generic advertising	Branded advertising
	Million dollars	
1982	5.8	56.4
1983	6.0	57.8
1984	21.7	83.3
1985	56.5	78.9
1986	58.0	73.2
1987	49.7	51.3
1988	42.2	89.5
1989	37.5	85.8
1990	37.3	104.0
1991, January-June	17.9	68.2

hand, a 10-percent decrease in the price of processed cheese would increase processed consumption by only 8 percent. Both price elasticities are statistically significant at the 5-percent probability level.

Demand for both natural and processed cheese seems insensitive to income changes. The estimated income elasticities for natural and processed cheese are about 0.13 and 0.02 and are not statistically significant.

The estimated cross-price elasticities between quantities of natural cheese purchased and the prices of processed cheese and meat are 0.9 and 0.8 and are statistically significant. The cross-price elasticities measure the extent to which price changes of its substitutes or complements influence demand for a good. A positive cross-price elasticity suggests that two commodities are substitutes. A negative cross-price elasticity suggests that the two commodities are complements. The estimated cross-price elasticities between processed cheese purchases and natural cheese, meat, and imitation cheese are about 0.2, 0.9, and 0.4. However, the natural cheese cross-price elasticity is not statistically significant.

Government donations have negative influences on both natural and processed cheese consumption. The estimated donation coefficient indicates that, for a 10-percent increase in cheese donations, the market

Table 7--Summary of natural cheese model estimates, January 1982-June 1991

Source	Estimated b values	T for H:b = 0	Prob T	Standard error of estimate
Intercept	-1.640	-1.033	0.3045	1.589
$\log(p^n)$	-1.524	-5.748	.0001	.265
$\log(p^p)$	.876	4.178	.0001	.208
$\log(p^m)$	.782	6.720	.0001	.116
log(Y)	.134	.684	.4957	.197
d	-.001	-2.625	.0101	.001
t	-.004	-5.532	.0001	.001
Djan	-.122	-7.148	.0001	.017
Dfeb	-.143	-7.088	.0001	.020
Dmar	-.143	-8.886	.0001	.016
Dapr	-.174	-12.257	.0001	.014
Dmay	-.195	-11.263	.0001	.017
Djun	-.216	-13.709	.0001	.016
Djul	-.251	-13.528	.0001	.019
Daug	-.219	-10.607	.0001	.021
Dsep	-.186	-11.042	.0001	.017
Doct	-.159	-8.740	.0001	.018
Dnov	-.111	-10.679	.0001	.010
advb	.005	1.730	.0870	.003
advg	*	-1.431	.1558	*
rho	-.249	2.487	.0132	.100
c	.7			
L	.001			
s	.7			
H	.3			

Note: rho is the first-order autocorrelation coefficient.
Adjusted R^2 = 0.96.
Number of observations = 113.
Degrees of freedom = 92.
* The b value for advg is -0.0003, its standard error 0.0002.

demand for natural cheese decreases by 0.01 percent. A 10-percent increase in cheese donations reduces processed cheese sales by 0.02 percent. Both parameter estimates are statistically significant at the 5-percent probability level.

Because demand for processed cheese did not demonstrate seasonal fluctuations, only natural cheese demand is modeled with seasonal variables. Using December as a base, all monthly dummy coefficients have negative signs, indicating that natural cheese demand is lower in months other than December. The lowest consumption month for natural cheese is July, when the seasonal coefficient is about -0.25. Natural cheese consumption also has a negative trend, -0.004, that is statistically significant.

Branded advertising is more influential than generic advertising in the natural cheese equation, a reverse of the situation from the previous year's report. The estimated branded advertising coefficient is -0.005 and is significant at the 10-percent probability level. The generic advertising coefficient is -0.0003 and less significant. The increased branded advertising effect is perhaps due to the large increase in branded expenditures in recent years. The parameters of gamma distribution for branded advertising, s = 0.7 and H = 0.3, provide a carryover effect with the highest weights in the second period and decline gradually thereafter. Generic advertising, on the other hand, has gamma distribution with parameters c = 0.7 and L =0.001, thus providing the highest response in the current period and declining immediately to nil in the third period.

Advertising is more effective for increasing demand for processed cheese than for natural cheese. The estimated coefficient for the weighted inverse of branded and generic advertising in the processed cheese equation is -0.325 and significant at the 5-percent probability level. The time shape of advertising effects as obtained from the gamma distribution parameters, g = 0.1 and G = 0.9, demonstrates a high current consumption effect and slow declining carryover effects, with advertising expenditures 12 months previous having about 40 percent of the effect of current-period advertising.

Table 8--Summary of processed cheese estimates, January 1982-June 1991

Source	Estimated b values	T for H:b=0	Prob T	Standard error of estimate
Intercept	-1.222	-1.923	0.0071	0.635
log(p^n)	.179	1.210	.2289	.148
log(p^p)	-.787	-3.769	.0003	.209
log(p^i)	.363	3.235	.0016	.112
log(p^m)	.948	3.559	.0006	.266
log(Y)	.024	.307	.7595	.078
d	-.002	-2.367	.0198	.001
adv	-.325	-2.858	.0051	.113
rho	-.592	-7.530	.0001	.079
g	.1			
G	.9			

Note: rho is the first-order autocorrelation coefficient.
Adjusted R^2 = 0.84.
Number of observations = 113.
Degrees of freedom = 105.

Cheese Entry and Exit Demand

Examining the proportion of all households purchasing cheese and the average amount of cheese they purchased provides analysis of entry and exit for cheese. Table 9 presents the estimates for the proportion of households purchasing natural cheese. All variable coefficients have the expected signs, and most are significant at the 10-percent or greater probability level. A 10-percent increase in the price of natural cheese reduces the proportion of households in the market by about 5 percent. A 10-percent increase in the price of substitution goods, namely either processed cheese or meats, increases the proportion of households in the natural cheese market by 4 percent. A 10-percent increase in the amount of donations reduces the proportion of households purchasing natural cheese by 0.01 percent.

Income did not have much influence on the proportion of households buying natural cheese. The largest decrease in the proportion of households buying natural cheese is in summer. February induces a larger proportion of households to enter the natural cheese market. There is also a negative, but very small, longrun trend in the percentage of households buying natural cheese.

Table 9--Estimates of the proportion of households purchasing natural cheese, January 1982-June 1991

Source	Estimated b values	T for H:b=0	Prob T	Standard error of estimate
Intercept	5.657	5.831	0.0001	0.9702
$\log(p^n)$	-.465	-2.813	.0060	.1653
$\log(p^p)$	.369	2.846	.0054	.1296
$\log(p^m)$	.366	5.240	.0001	.0699
log(Y)	.179	1.488	.1402	.1201
d	-.001	-2.337	.0216	.0003
t	-.001	-3.248	.0016	.0004
Djan	-.073	-6.829	.0001	.0108
Dfeb	.044	3.578	.0006	.0123
Dmar	-.072	-7.215	.0001	.0100
Dapr	-.037	-4.218	.0001	.0089
Dmay	-.109	-10.057	.0001	.0108
Djun	-.080	-8.204	.0001	.0098
Djul	-.140	-12.023	.0001	.0116
Daug	-.119	-9.215	.0001	.0129
Dsep	-.051	-4.851	.0001	.0105
Doct	-.081	-7.042	.0001	.0115
Dnov	-.001	-.245	.8068	.0067
advb	.002	1.441	.1530	.0016
advg	*	-2.415	.0177	.0001
rho	-.195	-1.921	.0550	.1017
c	.7			
L	.001			
s	.7			
H	.3			

Adjusted R^2 = 0.96.
Number of observations = 113.
Degrees of freedom = 92.
* The b value for advg is -0.0003.

Unlike the total market demand for natural cheese, generic advertising has a positive and statistically significant influence on the proportion of households buying natural cheese. A 10-percent increase in the weighted inverse of current and past generic advertising expenditures is associated with a 0.003-percent increase in the proportion of households in the natural cheese market. Branded advertising was significant at about the 15-percent probability level. In the per capita market demand equation, branded advertising had a significant positive effect on the quantity demanded.

The average quantity demanded for a product in the market is related to its total market demand through the number of households in the market. Thus, the average-quantity equation should have similar results as those obtained from the market demand and household proportion equations. Table 10 provides the estimates of the average-quantity demand equation. The price coefficient is reduced to 75 percent of the price coefficient in the total market demand equation, and substitution and seasonal effects are reduced by 50 percent. Only income and advertising effects are different. The income effect increased in magnitude and was significant. Advertising, either generic or branded, was not significant in the average-quantity purchased model.

Table 10--Estimates of the average quantity of natural cheese bought by purchasing households, January 1982-June 1991

Source	Estimated b values	T for H:b=0	Prob T	Standard error of estimate
Intercept	-2.436	-1.936	0.0559	1.2578
$\log(p^n)$	-1.025	-5.068	.0001	.2022
$\log(p^p)$	.471	2.949	.0040	.1596
$\log(p^m)$	.405	4.263	.0001	.0951
log(Y)	.279	1.795	.0759	.1556
d	-.001	-1.675	.0973	.0004
t	-.002	-4.405	.0001	.0005
Djan	-.050	-3.934	.0001	.0128
Dfeb	-.083	-5.203	.0001	.0160
Dmar	-.072	-5.907	.0001	.0122
Dapr	-.105	-9.572	.0001	.0110
Dmay	-.089	-6.713	.0001	.0132
Djun	-.104	-8.586	.0001	.0121
Djul	-.114	-8.070	.0001	.0141
Daug	-.103	-6.554	.0001	.0157
Dsep	-.104	-8.053	.0001	.0129
Doct	-.082	-5.906	.0001	.0138
Dnov	-.080	-10.373	.0001	.0077
advb	.002	.947	.3459	.0021
advg	*	-.098	.9221	.0002
rho	-.336	-3.434	.0012	.0977
c	.7			
L	.001			
s	.7			
H	.3			

Adjusted R^2 = 0.90.
Number of observations = 113.
Degrees of freedom = 92.
* The b value for advg is -0.00001.

Results for entry and exit for processed cheese are presented in tables 11 and 12. The own-price coefficient in this equation is not significant, indicating that entry or exit in the processed cheese market is not influenced by its price. For the substitution factors, prices of natural cheese, imitation cheese, and meat all affected household decisions to enter the market for processed cheese. A 10-percent rise in prices for these substitution goods increases the proportion of households entering the processed market by 4 percent, 3 percent, and 9 percent. Increased consumer income also affects household entry into the cheese market. A 10-percent increase in income is associated with a 9-percent increase in the percentage of households in the processed cheese market. Government donations have no significant effect. Advertising induces entry of consumers into the processed cheese market. A 10-percent increase in the weighted inverse of combined advertising increases the proportion of households in the processed cheese market by about 3 percent.

Table 11--Estimates of the proportion of households purchasing processed cheese, January 1982-June 1991

Source	Estimated b values	T for H:b=0	Prob T	Standard error of estimate
Intercept	-3.257	-5.298	0.0001	0.6149
log(p^n)	.357	2.601	.0106	.1374
log(p^p)	.136	.708	.4805	.1919
log(p^i)	.274	2.599	.0107	.1053
log(pm)	.931	4.078	.0001	.2283
log(Y)	.918	12.049	.0001	.0762
d	.001	1.337	.1840	.0007
advb	-.266	-2.874	.0049	.0927
rho	-.496	-5.861	.0001	.0847
g	.1			
G	.9			

Adjusted R^2 = 0.75.
Number of observations = 113.
Degrees of freedom = 105.

Table 12--Estimates of the average quantity of processed cheese bought by purchasing households, January 1982-June 1991

Source	Estimated b values	T for H:b=0	Prob T	Standard error of estimate
Intercept	-0.711	-1.804	0.0741	0.3942
log(p^n)	.055	.678	.4992	.0807
log(p^p)	-.568	-5.098	.0001	.1114
log(p^i)	.131	2.089	.0391	.0626
log(p^m)	.326	2.728	.0075	.1194
log(Y)	.035	.714	.4768	.0492
d	*	-3.478	.0007	.0004
advb	-.103	2.289	.0241	.0449
rho	-.315	3.399	.0012	.0926
g	.1			
G	.9			

Adjusted R^2 = 0.82.
Number of observations = 113.
Degrees of freedom = 105.
* The b value of d is -0.0001.

As with the natural cheese estimates, the average-quantity equation for processed cheese provides similar but smaller demand effects compared with those obtained from the market demand. A 10-percent increase in own-price reduces average quantity of processed cheese consumed by 6 percent. Natural cheese is not a significant substitute for processed cheese in this equation. A 10-percent increase in the price of imitation cheese or meat affects average purchases of processed cheese by 1 percent and 3 percent.

Income is not significant in the average-quantity equation. The effect of advertising is only a third of that obtained from the market demand equation for processed cheese.

Simulations of the Cheese Demand Equations

The purposes of our simulations are to (1) examine the effects on cheese purchases of increased generic advertising after passage of the act, (2) examine changes in cheese consumption at different levels of advertising expenditures, and (3) examine the effects on cheese purchases of changes in cheese prices, substitute prices, and income.

The statistical error associated with each estimate of the natural and processed cheese demand equations is small enough to permit a statistically founded conclusion that advertising increases the demand for cheese. Thus, we can use these estimated-demand equations for generic advertising with sufficient confidence to simulate the total effect of advertising on cheese purchases. We used the following procedures to simulate the effect on cheese purchases of increased generic advertising after passage of the act. First, we simulated per capita consumption from the natural and processed cheese equations using the actual levels of generic advertising. Next, we simulated per capita consumption by assuming that generic advertising remained at the monthly per capita levels of the year before the implementation of the act, September 1983-August 1984. For this procedure, we assumed that, in the absence of the act, generic advertising dollars spent would have increased over time at the same rate as inflation in media costs. We then estimated per capita consumption of natural and processed cheese on a monthly basis during September 1984-June 1990. The only factor that differed between the simulations was the level of generic advertising expenditures. We kept all other factors at actual levels observed during the period.[1] The difference in per capita consumption between the simulations is an estimate of the effects of the act. We then obtained the national effects of the act by expanding the per capita effect by total population.

Table 13 presents the advertising simulations. The table indicates that increased generic advertising expenditures due to the act increased national consumption of natural cheese at home by 24.5 million pounds during September 1984-June 1991. Total national consumption of natural cheese at home during the same period was 7.8 billion pounds. Similar estimates from the processed cheese model indicate that increased generic advertising caused by the act increased national consumption of processed cheese at home by 290.4 million pounds. Total national consumption of processed cheese at home was 5.5 billion pounds. Because of the sustained effect of past advertising on current consumption, generic advertising appears to be much more effective in increasing total consumption of processed cheese.

To examine consumption changes at different levels of advertising expenditures, we simulated the effect of increasing (decreasing) real generic advertising expenditures by 10 percent above (below) the actual amount spent during September 1984-June 1991. Results indicate that a 10-percent increase or decrease in generic advertising expenditures for cheese would have virtually no effect on natural cheese consumption. A 10-percent increase (decrease) in advertising expenditures, however, would have increased (decreased) processed cheese consumption by 24.0 (25.7) million pounds.

We used similar procedures to simulate the effects on cheese purchases of changes in other model variables. First, we simulated per capita consumption from the natural and processed cheese equations using the actual

[1] This control implies that the behavior of branded cheese advertisers did not change in response to the expanded generic programs. In reality, branded advertising dollars increased dramatically when the act became effective. If branded advertising increased as a result of the act, then our simulation underestimates the effect of the legislation.

levels of all variables. Next, we simulated per capita consumption assuming that the variable of interest, say natural cheese prices, remained at the monthly levels of the year before the act, September 1983-August 1984. The only factor that differed between the simulations was the level of the variable under study. We kept all other factors at actual levels observed during the period. The difference in per capita consumption between the simulations is an estimate of the effect of changes in an individual variable. We then obtained the national effects by multiplying the per capita effects by the total population (table 14).

Falling real natural cheese prices, down 9.1 percent on average from September 1983-August 1984 to September 1984-June 1991, increased natural cheese sales by about 1,082.3 million pounds, all other

Table 13--Summary of model simulation results on the effect of regional and national generic cheese advertising on national at-home consumption, September 1984-June 1991

Item	Unit	Sales/advertising results
Total sales of natural cheese	*Million pounds*	7,843.0
Total sales of processed cheese	*do.*	5,473.8
Estimated increase in national and regional advertising expenditures due to act	*Million dollars*[1]	263.1
Natural cheese:		
Sales gain due to advertising	*Million pounds*	24.5
As a share of total sales	*Percent*	.3
Per advertising dollar	*Pounds*	.1
Processed cheese:		
Sales gain due to advertising	*Million pounds*	290.4
As a share of total sales	*Percent*	5.3
Per advertising dollar	*Pounds*	1.1

[1] Includes 25 percent of the calcium advertising of the National Dairy Promotion and Research Board.

Table 14--Summary of model simulation results on the effects of changes in selected variables on consumption of natural and processed cheese at home, September 1984-June 1991

Item	Sales results
	Million pounds
Sales gain or loss due to changes in selected variables:	
Natural cheese--	
Decreasing price of natural cheese	1,082.3
Decreasing price of processed cheese	-449.8
Decreasing price of meat, poultry, and fish	-91.9
Increasing income	87.4
Processed cheese--	
Decreasing price of natural cheese	-101.8
Decreasing price of processed cheese	270.8
Decreasing price of meat, poultry, and fish	-81.0
Increasing income	11.0

variables constant. This change in natural cheese prices reduced processed cheese sales by about 101.8 million pounds, because natural and processed cheeses are substitutes. A 6.5-percent decline in real processed cheese prices between these periods increased processed sales by 270.8 million pounds. A 1.4-percent drop in real prices of meat, poultry, and fish reduced natural cheese sales by 91.9 million pounds and processed cheese sales by 81 million pounds. Rising real consumer income, up 8.5 percent, increased natural cheese sales approximately 87.4 million pounds and processed cheese sales by 11 million pounds.

Study Limitations

In their comparative static analysis of optimal advertising policy, Nerlove and Waugh (1961) noted that without supply control, the elasticities of supply, demand, and longrun marginal revenue of advertising jointly determine the optimal advertising expenditures. If the model is cast in a dynamic framework, optimal advertising policy also depends on the expected rates of change in demand and supply shifters, the temporal distribution of advertising effects, and the discounting rate of investment (Nerlove and Arrow, 1962). Because we use a shortrun static framework, supply is implicitly fixed. Thus, the advertising effects from this study could be larger than if we assume a flexible supply that responds to increased demand.

The other limitations of this study are related to the data. First, the fluid milk model encompasses only 40 percent of national milk consumption. For the cheese analysis, MRCA data measure only household purchases of cheese at retail establishments for off-premise consumption. MRCA did not measure cheese consumed away from home or as a component of a food product. USDA per capita disappearance data suggest that cheese use has increased over time, but the MRCA data show it generally declining. Such data differences suggest that growth in eating away from home and the consumption of cheese in food mixtures more than offset the downward trend in purchases for consumption at home. Generic advertising may affect consumption of cheese away from home and food mixtures containing cheese that are not measured with the MRCA data. Thus, our estimates may understate the total effects of generic advertising.

Another area that requires attention is the data for the advertising variable. Advertising expenditures in dollars and cents is a convenient measure of the theoretical concept of an advertising variable. However, these expenditures take several forms depending on the controlling agent, the types of media used, and the message content. In other words, the quality of advertising is not evident from an expenditure measurement.

The issue of how best to model the effects of past advertising on current consumption should also receive more attention. This critical issue can significantly affect the simulated effects of advertising expenditures on consumption.

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Appendix: Definition of Regions

Region	Federal marketing order number	Marketing area	
		States	Minor civil divisions
California	Not available	California	Entire State.
Eastern Colorado	137	Colorado	Adams, Arapahoe, Boulder, Cheyenne, Clear Creek, Crowley, Custer, Denver, Douglas, Elbert, El Paso, Gilpin, Huerfano, Jefferson, Kiowa, Kit Carson, Larimer, Las Animas, Lincoln, Logan, Morgan, Otero, Park, Phillips, Pueblo, Sedgwick, Teller, Washington, Weld, and Yuma Counties.
		Kansas	Cheyenne, Logan, Sherman, and Wallace Counties.
Georgia	7	Georgia	Entire State except Catoosa, Chattooga, Dade, Fannin, Murray, Rabun, Walker, and Whitfield Counties.
Great Basin	139	Idaho	Bannock, Bear Lake, Bingham, Bonneville, Caribou, Franklin, Jefferson, Madison, Oneida, and Power Counties.
		Nevada	Clark, Elko, Lincoln, and White Pine Counties.
		Utah	Beaver, Box Elder, Cache, Carbon, Daggett, Davis, Duchesne, Emery, Garfield, Grand, Iron, Juab, Kane, Millard, Morgan, Piute, Rich, Salt Lake, San Juan, Sanpete, Sevier, Summit, Tooele, Uintah, Utah, Wasatch, Washington, Wayne, and Weber Counties.
		Wyoming	Lincoln and Uinta Counties.
Greater Kansas City	64	Kansas	Atchison, Brown, Clay, Cloud, Dickinson, Doniphan, Douglas, Geary, Jackson, Jefferson, Johnson, Leavenworth, Lyon, Marshall, Miami, Morris, Nemaha, Ottawa, Pottawatomie, Republic, Riley, Saline, Shawnee, Wabaunsee, Washington, and Wyandotte Counties.
		Missouri	Andrew, Atchison, Bates, Buchanan, Cass, Clay, Clinton, Daviess, De Kalb, Gentry, Henry, Holt, Jackson, Johnson, Lafayette, Nodaway, Pettis, Platte, St. Clair, and Worth Counties.

Continued--

Appendix: Definition of Regions--Continued

Region	Federal marketing order number	Marketing area	
		States	Minor civil divisions
Middle Atlantic	4	Delaware	Entire State.
		District of Columbia	Entire District.
		Maryland	Anne Arundel, Baltimore, Calvert, Caroline, Carroll, Cecil, Charles, Dorchester, Frederick, Harford, Howard, Kent, Montgomery, Prince Georges, Queen Annes, St. Marys, Somerset, Talbot, Washington, Wicomico, and Worcester Counties; and the city of Baltimore.
		New Jersey	Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester, Mercer, and Salem Counties; the boroughs of Barnegat Light, Beach Haven, Harvey Cedars, Ship Bottom, and Tuckerton; and the townships of Eagleswood, Lacey, Little Egg Harbor, Long Beach, Ocean, Stafford, and Union in Ocean County.
		Pennsylvania	Adams, Bucks, Chester, Cumberland, Dauphin, Delaware, Franklin, Fulton, Juniata, Lancaster, Lebanon, Montgomery, Perry, Philadelphia, and York Counties.
		Virginia	Arlington, Fairfax, Loudoun, and Prince William Counties and the cities of Alexandria, Fairfax, and Falls Church.
New England	1	Connecticut	Entire State.
		Massachusetts	Barnstable, Bristol, Essex, Franklin (except the towns of New Salem, Orange, and Warwick), Hampden (except the towns of Brimfield, Monson, Palmer, and Wales), Hampshire (except the town of Ware), Middlesex, Norfolk, Plymouth, Suffolk, and Worcester (except the towns of Athol, Barre, Douglas, East Brookfield, Hardwick, New Braintree, Northbridge, North Brookfield, Petersham, Phillipston, Royalston, Templeton, Uxbridge, Warren, West Brookfield, and Winchendon) Counties.
		New Hampshire	Belknap, Cheshire, Grafton (the towns of Ashland, Bridgewater, Bristol, Holderness, and Plymouth),Hillsborough, Merrimack, Rockingham, Strafford, and Sullivan (except the town of Plainfield) Counties.
		Rhode Island	Entire State except the town of New Shoreham (Block Island) in Washington County.
		Vermont	Bennington (the towns of Landgrove, Peru, and Winhall), Windham (except Somerset), and Windsor (the towns of Andover, Baltimore, Cavendish, Chester, Ludlow, Plymouth, Reading, Springfield, Weathersfield, Weston, West Windsor, and Windsor) Counties.
Southeastern Florida	13	Florida	Broward, Dade, Glades, Hendry, Indian River, Martin, Monroe, Okeechobee, Palm Beach, and St. Lucie Counties.

Continued--

Appendix: Definition of Regions--Continued

Region	Federal marketing order number	Marketing area	
		States	Minor civil divisions
Southern Michigan	40	Michigan	Alcona, Alpena, Antrim, Arenac, Barry, Bay, Benzie, Calhoun, Charlevoix, Cheboygan, Clare, Clinton, Crawford, Eaton, Emmet, Genesee, Gladwin, Grand Traverse, Gratiot, Huron, Ingham, Ionia, Iosco, Isabella, Jackson, Kalamazoo, Kalkaska, Kent, Lake, Lapeer, Leelanau, Livingston, Macomb, Manistee, Mason, Mecosta, Midland, Missaukee, Montcalm, Montmorency, Muskegon, Newaygo, Oakland, Oceana, Ogemaw, Osceola, Oscoda, Otsego, Ottawa, Presque Isle, Roscommon, Saginaw, St. Clair, Sanilac, Shiawassee, Tuscola, Washtenaw, Wayne, and Wexford Counties; the townships of Dorr, Gunplain, Hopkins, Leighton, Martin, Otsego, Watson, and Wayland in Allegan County; the townships of Ash and Berlin in Monroe County.
Texas	126	Texas	Anderson, Andrews, Angelina, Aransas, Archer, Austin, Bastrop, Baylor, Bee, Bell, Bexar, Borden, Bosque, Brazoria, Brazos, Brooks, Brown, Burleson, Burnet, Caldwell, Calhoun, Callahan, Cameron, Camp, Chambers, Cherokee, Clay, Coke, Coleman, Collin, Colorado, Comal, Comanche, Cooke, Coryell, Dallas, Dawson, Delta, Denton, De Witt, Duval, Eastland, Ector, Ellis, Erath, Falls, Fannin, Fayette, Fisher, Foard, Fort Bend, Franklin, Freestone, Galveston, Glasscock, Goliad, Gonzales, Grayson, Gregg, Grimes, Guadalupe, Hamilton, Hardeman, Hardin, Harris, Harrison, Haskell, Hays, Henderson, Hidalgo, Hill, Hood, Hopkins, Houston, Howard, Hunt, Jack, Jackson, Jasper, Jefferson, Jim Wells, Johnson, Jones, Karnes, Kaufman, Kenedy, Kent, King, Kleberg, Knox, Lamar, Lampasas, Lavaca, Lee, Leon, Liberty, Limestone, Live Oak, Madison, Marion, Martin, Matagorda, McLennan, Midland, Milam, Mills, Mitchell, Montague, Montgomery, Morris, Nacogdoches, Navarro, Newton, Nolan, Nueces, Orange, Palo Pinto, Panola, Parker, Polk, Rains, Red River, Refugio, Robertson, Rockwall, Runnels, Rusk, Sabine, San Augustine, San Jacinto, San Patricio, Scurry, Shackelford, Shelby, Smith, Somervell, Stephens, Sterling, Stonewall, Tarrant, Taylor, Throckmorton, Titus, Tom Green, Travis, Trinity, Tyler, Upshur, Van Zandt, Victoria, Walker, Waller, Washington, Wharton, Wichita, Wilbarger, Willacy, Williamson, Wilson, Wise, Wood, and Young Counties.

Continued--

Appendix: Definition of Regions--Continued

Region	Federal marketing order number	Marketing area	
		States	Minor civil divisions
Upper Midwest	68	Iowa	Howard, Kossuth, Mitchell (except the city of Osage), Winnebago, Winneshiek, and Worth Counties.
		Minnesota	Entire State except Lincoln, Nobles, Pipestone, and Rock Counties.
		North Dakota	Barnes, Cass, Cavalier, Dickey, Grand Forks, Griggs, La Moure, Nelson, Pembina, Ramsey, Ranson, Richland, Sargent, Steele, Traill, and Walsh Counties.
		South Dakota	Brown, Day, Edmunds, Grant, McPherson, Marshall, Roberts, and Walworth Counties.
		Wisconsin	Ashland, Barron, Bayfield, Buffalo, Burnett, Chippewa, Clark, Douglas, Dunn, Eau Claire, Pepin, Pierce, Polk, Price, Rusk, St. Croix, Sawyer, Taylor, Trempealeau, and Washburn Counties.
Virginia	Not available	Virginia	Entire State except that area regulated under the Middle Atlantic order.

U.S. Department of Agriculture
Economic Research Service

SUMMARY OF REPORT

Food Consumption Up, Price Increases Slowed in 1990

Number 5, January 1993

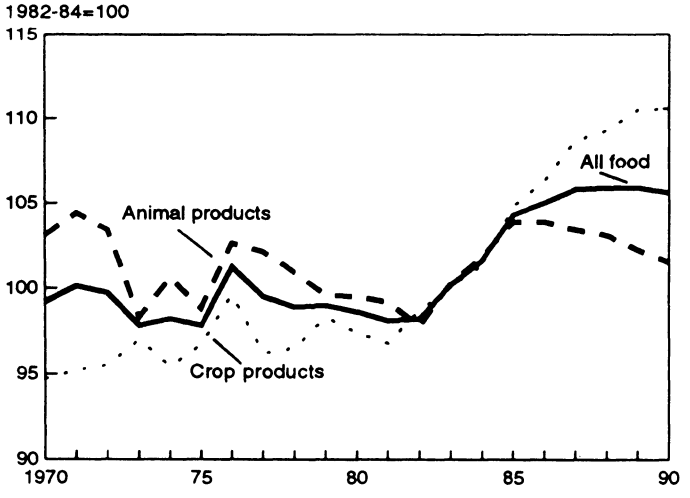
Contact: Judith Jones Putnam, 202-219-0870

The 1990 per capita food supply increased 6 percent from 1970, as consumption of crop-derived foods outpaced consumption of foods from animal products.[1] Retail food prices rose 2.9 percent in 1991, only half the 1990 price increase (5.8 percent) and the lowest since 1985. Americans spent $570 billion for food in 1991 and another $85 billion for alcoholic beverages. Away-from-home meals and snacks captured 45 percent of the U.S. food dollar in 1991, up from 39 percent in 1980, and 34 percent in 1970.

Food Consumption Trends

A trend having significant nutrition implications is the steadily increasing importance of crop-derived foods compared with foods from animal products. Between 1970 and 1990, consumption of crop-derived foods increased 17 percent while animal-based foods decreased 2 percent on a per capita basis.

Per capita food consumption index
Crop-based foods are outpacing foods from animal products.



[1]Based on a retail price-weighted quantity index.

Consumption of foods in most crop categories has risen steadily in the last 20 years, especially frozen potatoes, flour and cereal products, fresh and frozen vegetables, peanuts and tree nuts, fresh and processed fruits, vegetable fats and oils, and sweeteners. Crop products whose consumption declined between 1970 and 1990 are fresh potatoes, coffee, sweet potatoes, dry beans and peas, and vegetables for canning.

Americans used less whole milk, animal fats, eggs, and red meat. Increased consumption of lowfat milk, cheese, poultry, cream products, and fish and shellfish moderated the decrease in animal product consumption.

The U.S. Department of Agriculture's Economic Research Service annually calculates the amount of food available for human consumption in the United States. The U.S. food supply historical series measures national aggregate consumption of several hundred foods. It is the only source of time series data on food and nutrient availability in this country.

To Order This Report...

The information presented here is excerpted from ***Food Consumption, Prices, and Expenditures, 1970-90***, SB-840 ($14.00), by Judith Jones Putnam and Jane E. Allshouse. An electronic database is also available.

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