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Effects of Advertising on the Demand for Cheese

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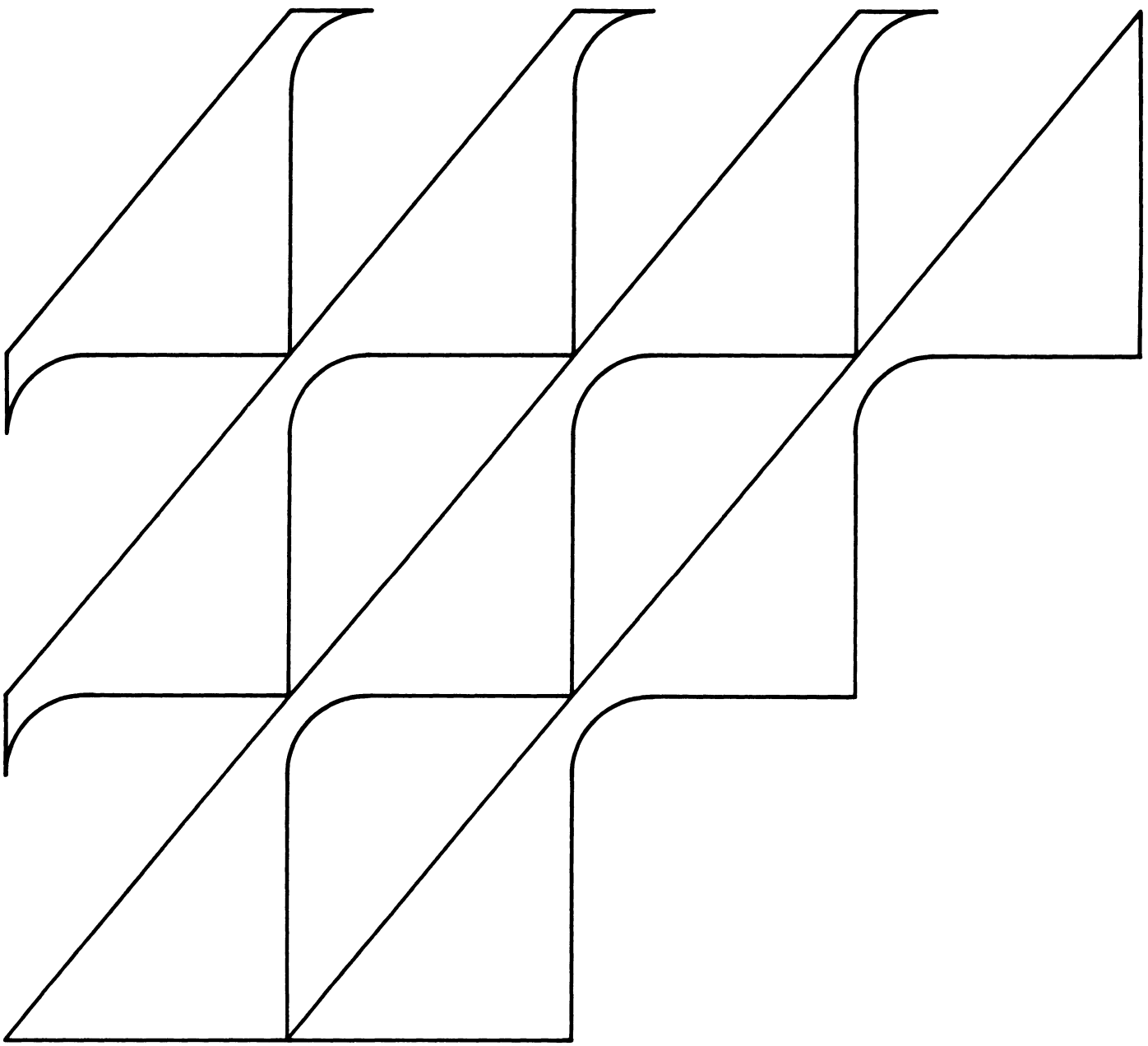

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EFFECTS OF ADVERTISING ON THE DEMAND FOR CHEESE. By James R. Blaylock and William N. Blisard. Commodity Economics Division, Economic Research Service, U.S. Department of Agriculture. Technical Bulletin Number 1752.

ABSTRACT

Increased advertising raised natural cheese sales by about 16 million pounds and processed cheese sales by about 98 million pounds during September 1984-June 1987. These sales were for cheese consumed at home. Declining real prices of natural cheese increased sales by about 189 million pounds. Increasing real incomes raised natural cheese sales by 123 million pounds and decreased processed cheese sales by about 5 million pounds. An assessment of 15 cents per hundredweight of milk sold commercially, mandated by the Dairy and Tobacco Adjustment Act of 1983, funded the advertising. The authors used estimated econometric demand models to simulate these results.

Keywords: Cheese, advertising, demand, entry, exit, distributed lag, econometric, generic, processed, elasticities.

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SUMMARY

Increased advertising raised natural cheese sales by about 16 million pounds and processed cheese sales by about 98 million pounds during September 1984-June 1987. These sales were for cheese consumed at home. Declining real prices of natural cheese increased sales by about 189 million pounds. Increasing real incomes raised natural cheese sales by 123 million pounds and decreased processed cheese sales by about 5 million pounds. An assessment of 15 cents per hundredweight of milk sold commercially, mandated by the Dairy and Tobacco Adjustment Act of 1983, funded the advertising. The authors used estimated econometric demand models to simulate these results.

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. The opposite is true for processed cheese. Advertising does not affect the number of households that purchase processed cheese, but it does lead to increased purchases by those households that would purchase processed cheese.

Government donations of cheese tend to dampen demand for processed cheese more than for natural cheese. Such donations have been used to decrease Government stocks of surplus cheese.

The authors developed separate econometric models to measure generic advertising's effects on demand for natural and processed cheese. They estimated their models with monthly data on cheese purchased for consumption at home during the period of January 1982 through June 1987. The data were collected by Market Research Corporation of America. The models specified per capita quantities of natural and processed cheese purchased as a function of prices, income, Government cheese donations, seasonal and trend factors, and advertising media expenditures. The performance of the models suggests that they can be used to measure the effects of both generic and branded advertising.

Effects of Advertising on the Demand for Cheese

James R. Blaylock
William N. Blisard *

INTRODUCTION

Both advertisers and producers of goods and services would like to know how advertising affects the demand for a particular product. Each year millions of dollars are spent on advertising in the hope that the public can be persuaded to purchase new products or to make additional purchases of goods already being consumed. In 1983, the Dairy and Tobacco Adjustment Act (Public Law 98-180) authorized a national program for dairy product promotion, research, and nutrition education as components of a comprehensive strategy to reduce milk supplies and increase consumption of milk and dairy products.

This bulletin reports on research to determine what effect advertising has had on the demand for natural and processed cheese. Specifically, the objectives of this study were to do the following:

(1) Determine what, if any, effect generic and branded advertising had on the demand for natural and processed cheese.

(2) Determine the dynamic structure of the effects of advertising on the demand for cheese. That is, to ascertain the length of time and the degree of magnitude that advertising affects sales beyond the initial period of product promotion.

(3) Determine if advertising increases the average quantity purchased by consumers, or if it induces consumers to enter the market, or if both effects occur.

We obtained data and estimated demand equations for natural and processed cheese over the period January 1982 through June 1987. We specified a gamma distributed lag to capture the dynamic aspects of the advertising variables. We chose the gamma lag because it is a flexible function that does not require the a priori specification of lag length. We feel that this choice allows the data to play a large role in determining the shape of the lag structure. We also estimated two additional equations for both natural and processed cheese. These two equations represent the proportion of all consumers in the market and the average quantity purchased. These two additional equations allowed us to determine if advertising induces consumers to enter the market or to make larger purchases.

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Despite the limited amount of data that we had to work with, we were able to tentatively meet all three objectives. We found that generic advertising was statistically significant in increasing the demand for natural cheese, but branded promotion was not. The estimated coefficients of the gamma lag function indicated that generic advertising influences consumption only in the current period.

For processed cheese, our results were not meaningful when we divided advertising into branded and generic variables. However, when we combined the two variables, we find that advertising had a statistically significant influence on 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.

Our results also indicate that generic advertising increased the proportion of consumers entering the natural cheese market, but that it does not induce those already in the market to increase their purchases. Branded advertising was found to have no effect on either variable. In the other two processed cheese equations, advertising had no effect on the proportion of consumers in the market, but it did induce those already in the processed cheese market to increase their purchases.

DAIRY AND TOBACCO ADJUSTMENT ACT

The Dairy and Tobacco Adjustment Act of 1983 (Public Law 98-180) authorized a national program for dairy product promotion, research, and nutrition education as components of a comprehensive strategy to reduce milk supplies and increase consumption of milk and dairy products. The promotion program is designed to strengthen the dairy sector's position in the market place and to maintain and expand domestic and foreign markets for dairy products produced in the United States.

The program is funded by a mandatory 15-cent per hundredweight assessment on farmers for all milk produced in the contiguous 48 States and marketed commercially by dairy farmers. The act provided that dairy farmers can receive a credit of up to 10 cents per hundredweight for contributions to continuing qualified regional, State, or local dairy product promotion or nutrition education programs.

The national program is administered by the National Dairy Promotion and Research Board composed of 36 dairy farmers appointed by the Secretary of Agriculture. The act also required the Secretary of Agriculture to conduct a referendum among producers to determine whether a majority of those voting favored continuing the dairy promotion and research order. The act mandated the referendum to be completed by September 30, 1985. On September 12, 1985, the Secretary of Agriculture announced that a significant majority voted to continue the order. The act made the U.S. Department of Agriculture (USDA) responsible for oversight of program activities of the National Dairy Board and required USDA to submit an annual report to the House of Representatives' Committee on Agriculture and the Senate's Committee on Agriculture, Nutrition, and Forestry by July 1 of each year. The report must contain, among other items, an independent analysis of the effectiveness of the program.

The Economic Research Service had primary responsibility for analyzing the effectiveness of generic advertising on increasing cheese consumption during 1984-86. This report contains the results of these analyses.

BACKGROUND ON ADVERTISING

Advertising is generally directed toward existing and potential consumers of a product with the ultimate objective of enhancing sales for the advertised product. "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. 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 does increase aggregate demand or at least reduces the rate of decline in consumption (Ward and Myers, 1979; Thompson, 1975; Ward, 1984). The empirical evidence that brand advertising is effective in increasing aggregate demand is less persuasive. Generic advertising, in theory, is brand neutral, but this may not always be the case if generic promotion emphasizes the common characteristics of a product group, and a concurrent brand advertising campaign stresses differences. Also, if one firm dominates the brand advertising for a particular product (such as in the processed cheese market), branded advertising may be serving both as a form of brand and generic promotion. Concurrent generic and brand advertising campaigns can have both complementary and competitive aspects, depending on the commodity and the nature of the promotion activities.

The following observations made by Ward, Chang, and Thompson (1985, page 275) appear relevant:

(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) relative to the persuasive nature of brand messages.

(3) Generic advertising probably has more factual information than brand 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 should have a negative impact on product differentiation, thus reducing barriers to entry and excessive profits (and margins) among first handlers beyond the farm gate.

(5) Generic advertising is likely to 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 benefitting from any economies of scale from advertising if such economies exist.

ADVERTISING AND DEMAND THEORY

The classical theory of consumer demand postulates that a consumer maximizes a utility function subject to a budget constraint. The result of this process is a set of demand relations, one for each commodity, which are functions of all prices and income. Several restrictions have been shown to apply to demand functions. (See Phlips, 1974, for a discussion of these restrictions.) 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). Estimation of complete demand systems requires information on prices and other demand factors for every commodity. If the focus of the analysis is on a single commodity and if variables other than prices and income are incorporated, the data requirements quickly become so extensive that the analysis becomes almost unmanageable. Thus, almost all examinations of the effect of advertising on consumer demand for a particular product have pragmatically focused on single-equation demand relations.

We have implicitly assumed that the supply curve for cheese is perfectly elastic. For most goods and commodities, such an assumption would be unrealistic. However, because milk is the major ingredient in cheese, and because milk has been in surplus over the period of study, we feel that the assumption of a perfectly elastic supply curve is warranted in this case.

Two approaches for incorporating advertising into the neoclassical theory of demand have predominated in the economic literature: the "advertising as information" approach and the "advertising as utility altering" approach. Neither of these approaches has reached a refined state of theoretical or empirical development. However, the "advertising as information" approach is overwhelmingly preferred because of the simplicity it implies for empirical applications.

The "advertising as utility altering" approach has as its foundation the premise that advertising, in some fashion, changes the consumers' utility function via its effects on consumer tastes and preferences. No economic theory exists that systematically explains the effect of advertising on consumers' tastes and preferences.

The "advertising as information" approach, as summarized by Rosen (1980) and refined by Verma (1980), is grounded in the theory of household production. The household production approach assumes that individual households combine information, time, and market goods to produce commodities that create utility for the household. In this approach, the household can be viewed as a small factory producing a number of commodities, some perhaps unobservable, in such a way as to maximize the household's well-being. Household demand functions for market goods are derived from the demand for these "home-produced" commodities and are constrained by the household's production technology. Advertising, to the extent that it provides low cost information to the household, represents a cost-saving factor. Thus, the amount of advertising exposure a household receives helps determine its productivity in supplying household commodities and hence alters the implicit prices. The major advantage of viewing advertising as information is that it can be introduced as an exogenous factor into the consumer demand function

for a particular good, along with traditional factors including market prices, income, and other demand determinants.

EMPIRICAL ISSUES AND PAST RESEARCH

Several important empirical issues relate to the estimation of single equation demand functions using aggregate data. These issues include the functional specification of the demand equation, specification of the advertising variable, and the modeling of the dynamic (or intertemporal) effects of advertising over time.

The most commonly used functional forms in demand analysis include the following:

$$q_i = a + \sum_{k=1}^{m} b_k x_k \qquad \text{(linear)} \qquad (1)$$

$$\ln(q_i) = a + \sum_{k=1}^{m} b_k \ln(x_k) \qquad \text{(double logarithmic)} \qquad (2)$$

$$q_i = a + \sum_{k=1}^{m} b_k \ln(x_k) \qquad \text{(semilogarithmic)} \qquad (3)$$

$$q_i = a - \sum_{k=1}^{m} b_k / x_k \qquad \text{(inverse)} \qquad (4)$$

$$\ln(q_i) = a - \sum_{k=1}^{m} b_k / x_k \qquad \text{(logarithmic inverse)} \qquad (5)$$

where q_i is the quantity consumed of the ith commodity, x_k represents the kth explanatory variable, and a and b_k (k=1 to m) are parameters to be estimated. All of the explanatory variables need not be transformed identically. Some variables may enter the equation in logarithmic form while others may enter linearly or inversely. The form by which variables enter the model is an empirical issue which cannot be resolved a priori. Researchers typically rely on goodness-of-fit measures, plausibility of parameter estimates, intuitive judgment, and simplicity of interpretation as guides for selecting functional specification.

All of the functional forms presented above have both desirable and undesirable characteristics. For example, the linear form (equation (1)) is easy to compute, and it satisfies the theoretical condition that expenditures on all goods sum to total income. Elasticities with respect to the kth variable for linear models tend to plus or minus unity as the kth variable (such as income or price) increases. For many food products, elasticities that tend toward zero are more realistic. Moreover, the linear form does not allow for a saturation level of consumption as income, for example, grows towards infinity.

The double-logarithmic form (equation (2)) has constant elasticities regardless of the price or income levels at which the elasticities are evaluated. This form does not satisfy the adding-up criterion, but it generally provides a good statistical fit. Despite its limitations, the double-logarithmic form is commonly

used in demand analysis because of its ease of estimation and direct economic interpretation of the parameters.

The semilogarithmic form's (equation (3)) elasticities tend toward zero as the value of the variable under consideration increases. The form satisfies the adding-up criterion and gives a good fit for many agricultural commodities. The inverse form (equation (4)) has elasticities which tend to increase as the variable under consideration increases. This form has often been used to represent expenditure functions. However, this use makes sense only if "a" is positive and the b_k under consideration is negative because "a" would then indicate an asymptotic level of expenditure. Thus, the expenditure variable must reach a critical level equal to $-b_k/a$ before anything is spent on the commodity in question. Hence, this form cannot serve as a general model when the researcher needs to allow for finite consumption of some commodity when the independent variable is close to zero.

The logarithmic-inverse form (equation (5)) has elasticities that are inversely proportional to the variable under consideration, and the slope of the curve is sigmoid. In addition, this form allows for finite expenditures when the dependent variable is close to zero. These characteristics are highly desirable. Like the inverse form (equation (4)), the statistical fit of the logarithmic inverse form is not often as good as the double logarithmic form. Thus, this form is not often used in empirical analysis. For a more complete discussion of the characteristics of the above functional forms, see Prais and Houthakker (1955).

The specification of the advertising variable is particularly important for analyzing the effects of advertising on cheese demand. Past research on advertising effectiveness provides some guidance in this area.

Two basic approaches for modeling advertising have been advanced. The first is to view promotion as a "flow" variable. The second is to regard advertising as a "stock" or "goodwill" variable. The latter interpretation assumes that at any point in time a certain amount of consumer goodwill toward a product exists as a result of current and past promotional efforts. Thus, advertising is measured by a variable that summarizes the effects of current and past advertising outlays on demand and that depreciates or decays over time much like a capital good. This approach is intuitively appealing, but it requires that the unknown decay structure be specified a priori. Therefore, most empirical research has used the "flow" interpretation which implicitly assumes that advertising enters the demand model in distributed lag form.

The "flow" approach assumes that advertising continues to affect sales beyond the initial period of promotion expenditure. Several empirical studies have confirmed the significance of this carryover effect. (See, for example, Clarke, 1976, and Jastram, 1956.) Also, recent research has indicated that a delayed response to advertising may exist, suggesting that the sales response to promotion requires time to build before the decay process actually takes over and the response begins to decline (Kinnucan, 1981, 1983). Thus, the sales-advertising relationship has a hump-shaped distribution over time with the total effect of advertising being the cumulative sum of responses over time. Because the evidence is strong that effects of advertising may not dissipate in the current period, researchers have often used flexible distributed-lag structures to model the results.

Distributed lag refers to a situation where the full reaction to a stimulus occurs only after some time lapse. The total response to the stimulus is not felt immediately but is distributed over time with carryover effects distributed beyond

the period of the initial stimulus. Several distributed-lag formulations have been used for characterizing the decay structure of advertising. These formulations have ranged from the Koyck model (Clarke, 1976), in which a geometrically declining set of weights are assigned to past promotion expenditures, to the Pascal model (Kinnucan and Fearon, 1984) which allows for a more realistic situation in which the weights on advertising expenditures start to increase and then decline after several periods due to a lagged effect in advertising response. A polynomial lag structure, as used by Ward (1984), appears to be a flexible approach, free of some of the statistical problems associated with other methods. The polynomial lag models allow for estimation of two or more lagged variables, such as generic and branded advertising, without imposing nonlinear constraints on the model. This lag structure also allows for an initial "buildup" of advertising effectiveness which is important when using monthly data (Clarke, 1976).

However, researchers using the polynomial distributed-lag have had trouble obtaining meaningful results without imposing rather severe restrictions on the model. These restrictions usually take the form of restricting the length of the lag and the end points. A class of distributed-lag models often referred to as infinite-lag models has several advantages over the polynomial lag. First, infinite-lag models do not require a priori specification of the length of the lag. Second, these models are very flexible in that the data largely determine the shape of the lag structure. These types of lag structures are, however, more difficult to estimate than many simpler specifications, and the analyst sometimes must restrict the parameters of the infinite-lag structure to obtain meaningful results. In our analysis, we used a flexible infinite-lag structure known as the gamma lag (Schmidt, 1974, Mitchell and Speaker, 1986). Regardless of the distributed-lag model selected, the length of the lag has to be empirically determined.

Specification of the functional form for the sales (or quantity purchased) and advertising relationship is very important because the form chosen constrains the shape of the sales-advertising relationship. The functional specifications presented above in equations (1)-(5) are the most commonly used (assume that variable x_1 represents advertising in these specifications). Economic theory and empirical evidence indicate diminishing marginal returns to advertising. After some level of advertising expenditures is reached, each additional dollar of promotion expenditures generates less of an increase in sales than the previous dollar of advertising (Simon and Arndt, 1980). This evidence would rule out the linear model because it implies constant returns. Only the double-logarithmic, semilogarithmic, inverse, and logarithmic-inverse forms merit serious consideration.

The double-logarithmic form, often used for analyzing the sales-advertising relationship, implies that the advertising elasticity does not vary with respect to the level of advertising. This implication contradicts the idea of a saturation level of advertising, that elasticity declines at higher levels of advertising. Also, a declining elasticity is necessary for the concept of a satiation level in cheese consumption to be valid.

The inverse and logarithmic-inverse models satisfy the criteria of diminishing marginal returns to promotion and satiation levels in consumption. The logarithmic-inverse function is particularly attractive if advertising expenditures cover a wide range of values, as is the case for generic promotion expenditures for cheese (Kinnucan, 1983). This function has a declining elasticity, implying diminishing returns to advertising, and a sigmoid shape. This particular shape implies increasing returns to advertising at low levels of

advertising expenditures but diminishing returns at higher levels. Consistent with the concept of a saturation level of advertising, the function asymptotically approaches an upper limit of sales, as measured by quantities purchased (Kinnucan, 1983). The inflexion point, the point that identifies the minimum level of advertising necessary to achieve diminishing returns, occurs at half the value of the advertising coefficient. These properties make the logarithmic-inverse form a good candidate for examining the sales-advertising relationship.

Also, only the double-logarithmic and logarithmic-inverse forms allow for the possibility of a synergistic interaction between generic and branded advertising (Kinnucan and Fearon, 1984). Thus, the functional form should have positive cross-derivatives with respect to the advertising variables. Both of these functions imply that the ability of one type of advertising to enhance the effectiveness of the other declines with the level of advertising. The rate of decline is more rapid with the logarithmic-inverse form.

ENTRY AND EXIT IN THE CHEESE MARKET

The preceding discussion of the theory of demand and of advertising has ignored what may be a significant analytical component, the effect of individual consumers' or households' beginning or ceasing to purchase a given commodity. Not all consumers will purchase a given commodity at all given prices. Rather, some consumers will choose not to purchase any of a given good at certain relative prices. As variables, including prices, income, and advertising expenditures, in the demand function change, some individuals will decide to enter the market while others may decide to exit.

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 by both methods. Haidacher (1964) developed a methodology for estimating the effect on the demand for a given good due to consumers' entering and exiting the market. His methodology is pertinent to studies such as this one which use aggregated data, rather than studies which use data for individual households. The latter studies would probably have a certain number of zero observations representing individuals or households not in the market. Analysis of data containing explicit zero observations would require the use of some type of limited dependent variable model.

The entry-exit phenomenon and its component parts can be easily demonstrated by focusing upon the own price elasticity for any good. First, at prices above some minimum level, N - r consumers will not purchase the commodity (N is the maximum number of potential consumers (assumed fixed), and r is the number of consumers actually purchasing the product). The proportion, Pr, of consumers purchasing at a given price is r/N. Next, we define the average quantity purchased by individuals in the market as:

$$q = 1/r \sum_{i=1}^{r} q_i. \qquad (6)$$

The summation of q_i over all consumers in the market is aggregate demand or Q; thus,

$$Q = q^*r. \qquad (7)$$

Then, because r=Pr*N, we simply substitute to get

$$Q = q * Pr * N. \quad (8)$$

Own price elasticity is defined as:

$$E_Q = \delta Q/\delta P_1 * P_1/Q. \quad (9)$$

However, if we define Q in terms of the entry and exit phenomena, our formula for elasticity will be

$$EQ = (\delta q/\delta P_1) * P_1/q + (\delta PrN)/\delta P_1 * P_1/(PrN), \quad (10)$$

or, because N can be considered a constant for variations in P_1,

$$EQ = \delta q/\delta P_1 * P_1/q + \delta Pr/\delta P_1 * P_1/Pr, \text{ or} \quad (11)$$

$$EQ = E_q + E_{Pr}. \quad (12)$$

Hence, the own price elasticity of market demand for any good consists of two components: the effect on the elasticity of average quantity purchased by consumers in the market, and the effect on the elasticity of the proportion of total consumers in the market.

We can estimate two additional equations to determine if changes in the quantity demanded for a good is due to consumers already in the market changing the average quantity purchased, or due to a change in the proportion of consumers in the market or due to both effects. As demonstrated above, 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. The summation of the estimated coefficients for a given variable from the two above curves should equal the corresponding estimated coefficient in the ordinary demand curve.

This methodology allows us to determine if cheese advertising is affecting the proportion of consumers entering the market or increasing the quantity purchased by those already in the market, or both.

TRENDS IN THE CHEESE MARKET

Several data bases can be examined in order to ascertain trends in the U.S. cheese market. These include the U.S. Department of Agriculture's (USDA) consumption data, which are based on disappearance data; the Continuing Consumer Expenditure Survey (CCES), published by the Bureau of Labor Statistics (BLS), U.S. Department of Labor; and the data collected by the Market Research Corporation of America (MRCA). (See the description of these data sets in app. I.)

USDA's data indicate that per capita cheese consumption has grown over the last two decades. This growth continued during 1984-86. Consumption of American cheese, the largest component of the cheese total, increased from 11.88 pounds per capita in 1984 to 12.20 pounds in 1985, then fell slightly in 1986 to 12.13 pounds per capita.

Government donations, which were substantial during 1984-86, are included in the cheese consumption figures. Per capita donations were 2.9 pounds in 1984, 2.6

pounds in 1985, and 2.5 pounds in 1986. Even when donations are removed from the disappearance data, consumption has still increased.

The USDA disappearance data include cheese consumed both at home and away from home. Information contained in the CCES can help determine the consumption of cheese at home through 1985, the most recently published data. However, because this survey is based on expenditures by consumers on specific products, we cannot determine the amount of cheese consumed as an ingredient in other foods. Nevertheless, CCES data indicate that per capita consumption of cheese at home has fallen steadily during 1980-85.

The MRCA data also indicate that per capita cheese consumption at home has fallen. Per capita consumption of natural cheese fell about 12 percent from 1982 through the first half of 1987. Per capita consumption at home of processed cheese also fell from 1982 to 1984, but has since risen by about 12 percent. However, because natural cheese represents the larger share of cheese consumption, the net effect has been a decline in cheese consumed at home.

The above information suggests that the increase in total cheese consumption is due to growth in the away from home market and, probably to a smaller extent, to the expanded use of cheese in other packaged products.

MODEL SPECIFICATION

Aside from advertising, many other factors influence the per capita quantity of cheese purchased, including the price of the product, prices and availability of substitute and complementary products, income, seasonality, trends, and Government donations. To isolate and measure the effects of advertising, one must account and control for the effect of these variables on quantities demanded.

In its July 1, 1985 report to Congress on the dairy promotion program, A.D. Little, Inc., the contractor for the research, developed and presented a cheese model. A USDA Evaluation Oversight Committee determined that the model had a specification error. Therefore, we did not use that model to estimate the marginal effect of the national generic advertising campaign on cheese purchases.

Processed and natural cheese purchase patterns, prices, and product characteristics are sufficiently different to warrant separate analyses for each product. Among these differences are the following:

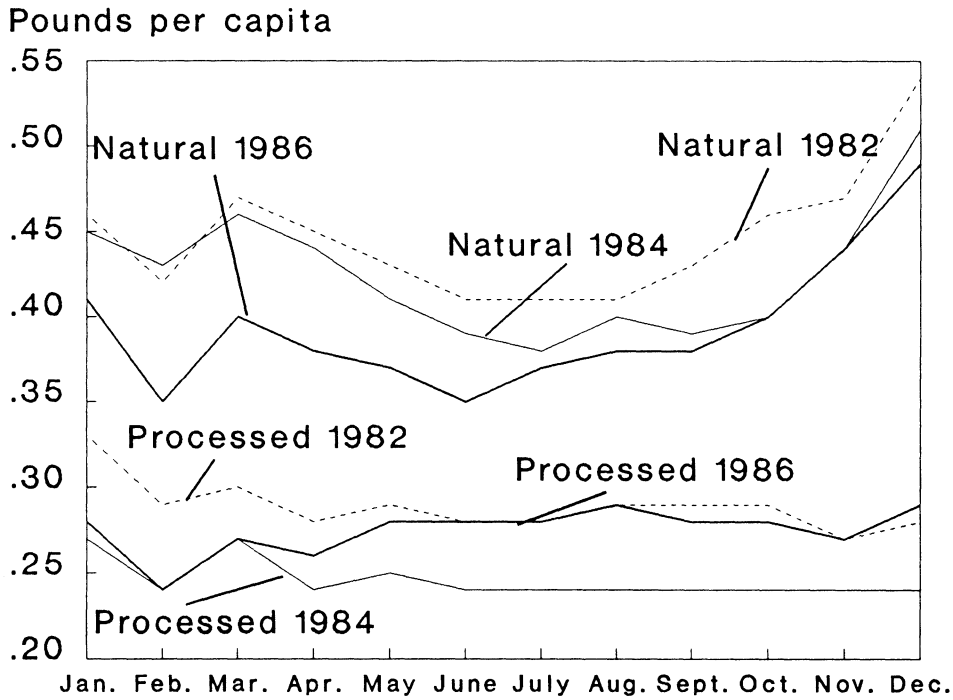
(1) Natural cheese purchases vary significantly by month and season, with a peak in December and a trough in July (fig. 1). Processed cheese purchases, however, vary much less from season to season (fig. 1).

(2) The MRCA data indicate that per person consumption of natural cheese at home fell steadily from 1982 through the first half of 1987, down about 12 percent (fig. 2). Per person consumption of processed cheese at home fell about 14 percent during 1982-84, rose about 12 percent during 1984-86, and fell below 1986 levels during the first half of 1987 (fig. 2). Per person consumption of processed and natural cheeses by buying households show the same patterns as per person consumption nationally.

The proportion of households purchasing natural cheese has fallen steadily from about 59.5 percent in 1982 to about 53.8 percent in 1987. The proportion of households buying processed cheese fell from 43.5

Figure 1

Monthly purchases of types of cheese for consumption at home



Source: Market Research Corporation of America

percent in 1982 to 37.8 percent in 1984 before climbing to over 40 percent in 1986 and 1987.

(3) Government donations of cheese under the Temporary Emergency Food Assistance Program were predominantly processed cheese (fig. 3). Hence, we would expect these donations to have a larger effect on purchases of processed cheese than on purchases of natural cheese.

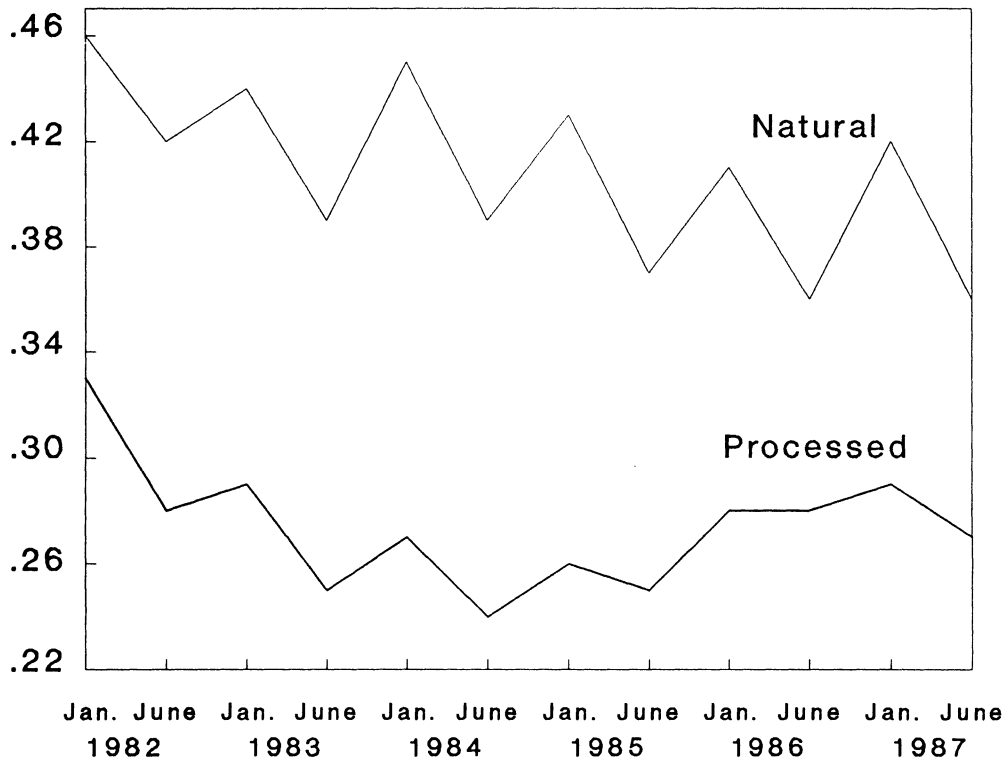
(4) Because natural cheese is a higher priced product than processed cheese, price and income probably have greater effects on purchases of natural cheese (fig. 4).

The demand and the entry and exit models for natural cheese can be written as follows:

Figure 2

Long-term trends in cheese purchases for consumption at home

Pounds per capita



Source: Market Research Corporation of America

$$\ln Q_t^n,\ \ln q_t^n,\ \ln Pr^n = \tag{13}$$

$$\beta_0 + \beta_1 \ln(P_a^n) + \beta_2 \ln(P_t^p) + \beta_3 \ln(P_t^m) + \beta_4 D_t$$

$$+ \beta_5 \ln(Y_t) + \beta_6 T_t + di \sum_{j=1}^{11} d_i M_i$$

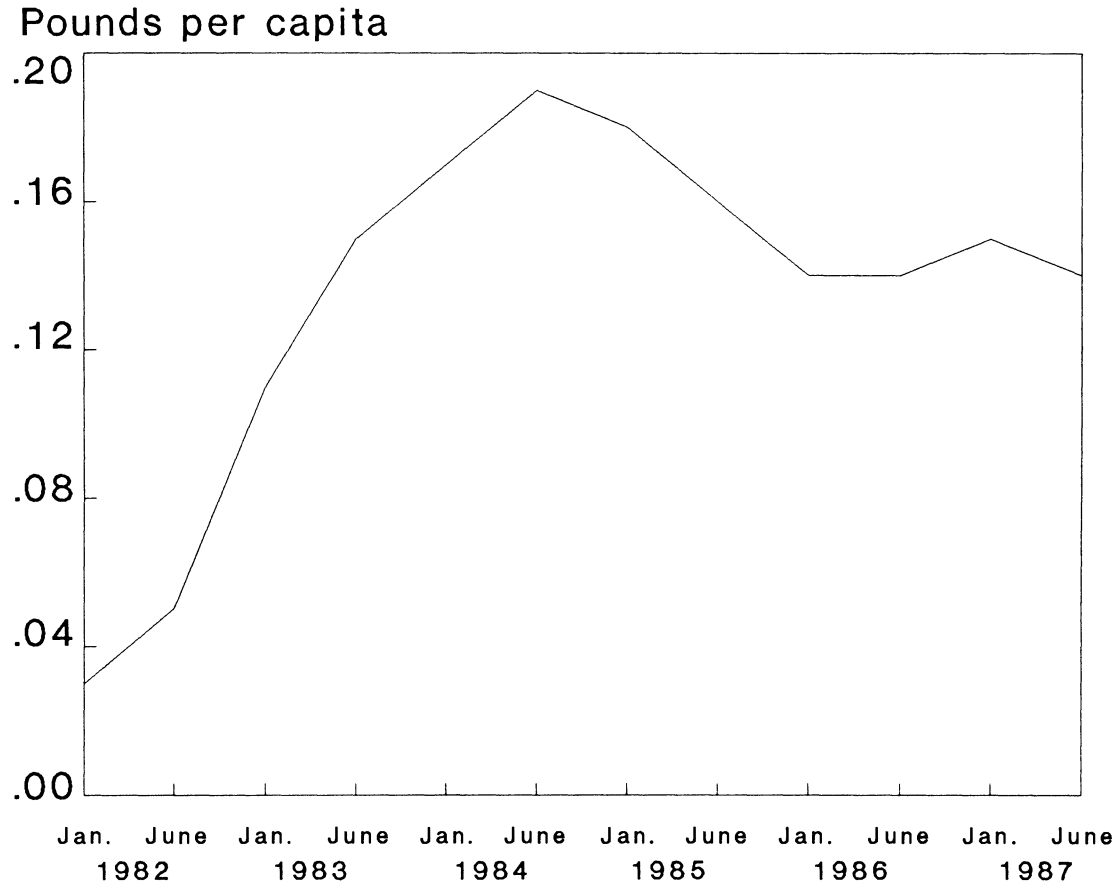
$$+ \alpha_1 \sum_{i=0}^{t-1} (i+1)^{c/(1-c)} L^i [1/(k_1 + A_{t-i}^g)]$$

$$+ \alpha_2 \sum_{i=0}^{t-1} (i+1)^{s/(1-s)} H^i [1/(k_2 + A_{t-i}^b)] + \varepsilon_t$$

Where

Figure 3

Government cheese donations



Q_t^n : per capita quantity of natural cheese purchases by U.S. households, in pounds per month t, t = 1 (January 1982), ..., t = 66 (June 1987);

q_t^n : average per capita quantity of natural cheese purchases by U.S. households purchasing natural cheese, in pounds per month t, t = 1 (January 1982),..., t = 66 (June 1987);

P_r^n : the proportion of all U.S. households which purchased natural cheese during month t, t = 1 (January 1982),..., t = 66 (June 1987);

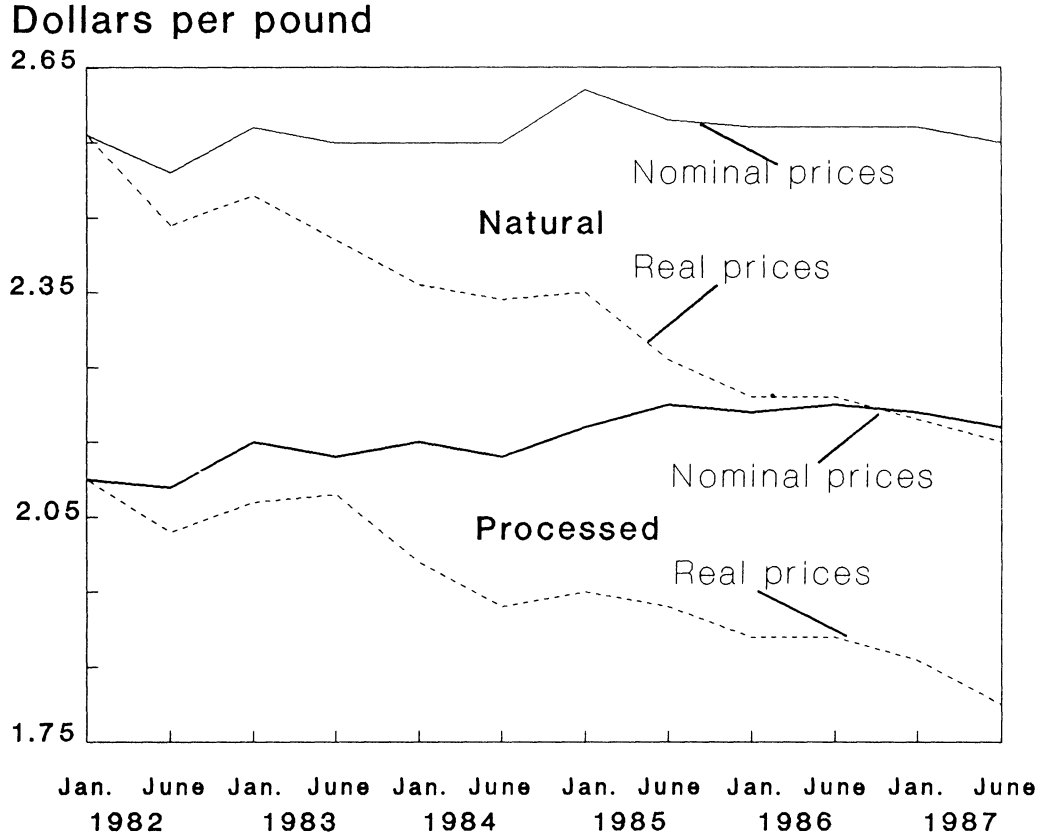
P_t^n : price of natural cheese in dollars per pound, deflated by the consumer price index (CPI) for all urban consumers (1977 = 100);

P_t^p : price of processed cheese in dollars per pound, deflated by the CPI;

P_t^m : price index for meat, poultry, and fish (1967 = 100) deflated by the CPI;

Figure 4

Average prices of natural and processed cheeses



Source: Market Research Corporation of America

Y_t : per capita disposable income in the United States in period t, deflated by the CPI;

D_t : per capita domestic donations of cheese in pounds under the USDA's Temporary Emergency Food Assistance Program;

T_t : Time trend, T = 1 if t = January 1982,..., T = 66 if t = June 1987;

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

$$\alpha_1 \sum_{i=0}^{t-1} (i+1)^{c/(1-c)} L^i [1/(k_1 + A^g_{t-i})]:$$

weighted average of current and past per capita generic advertising expenditures on natural cheese. Generic advertising expenditures are "deflated" by a media cost index.

The terms represented by $(i+1)^{c/(1-c)}\ L^i$ are weights placed on present and past advertising expenditures assuming a gamma lag structure where the values of the weights and general shape of the weight structure are determined by the parameters c and L. k_1 is an advertising constant (for example, word-of-mouth or other advertising which has a residual presence at any given time even if no generic advertising took place);

$$\alpha_2 \sum_{i=0}^{t-1} (i+1)^{s/(1-s)}\ H^i [1/(k_2 + A^b_{t-i})]:$$

weighted average of current and past per capita branded advertising expenditures on natural cheese in period t. Branded advertising expenditures are "deflated" by a media cost index.

The terms represented by $(i+1)^{s/(1-s)}\ H^i$ are the weights placed on present and past advertising expenditures assuming a gamma lag structure where the values of the weights and general shape of the weight structure are determined by the parameters s and H. k_2, like k_1 above, is an advertising constant.

d_i, β's, α_1, α_2, c, s, L, and H are model parameters to be estimated;
ε_t : first-order autoregressive equation error term where $\varepsilon_t = \rho\varepsilon_{t-1} + \mu_t$ and μ_t is assumed to be normally distributed with zero mean and constant variance.

The processed cheese models can be written mathematically as--

$$\ln Q^p_t,\ \ln q^p_t,\ \ln P^p_r = \tag{14}$$

$$\beta_0 + \beta_1 \ln(P^p_t) + \beta_2 \ln(P^n_t) + \beta_3 \ln(P^I_t) + \beta_4 \ln(P^m_t)$$

$$+ \beta_5 \ln(Y_t) + \beta_6 \ln(D_t)$$

$$+ \alpha_1 \sum_{i=0}^{t-1} (i+1)^{c/(1-c)}\ L^i [1/(k_3 + A^g_{t-i})]$$

$$+ \alpha_2 \sum_{i=0}^{t-1} (i+1)^{s/(1-s)}\ H^i [1/(k_4 + A^b_{t-i})] + \varepsilon_t$$

where all variables are as defined in the natural cheese equation except the following:

Q^p_t : per capita quantity of processed cheese purchases by households in the United States, in pounds per month t, t = 1 (January 1982)...,t = 66 (June 1987);

q^p_t : average per capita quantity of processed cheese purchases by households purchasing processed cheese, in the United States, in pounds per month t, t = 1 (January 1982)..., t = 66 (June 1987);

P_r^p : the proportion of all households in the processed cheese market in the United States per month t, t = 1 (January 1982)..., t = 66 (June 1987);

P_t^I : price of imitation cheese in dollars per pound, deflated by the CPI for all urban consumers (1977=100).

We obtained from MRCA all cheese prices (natural, imitation, and processed) and quantities. The time series data on household cheese purchases reflect aggregate national purchase data estimated from a continuing consumer panel survey. The data only include cheese purchased for direct consumption at home. Cheese consumed in restaurants or other away-from-home establishments and cheese consumed in connection with purchased foods (for example, pizzas and macaroni and cheese mixtures) are not included. Cheese prices refer to retail prices.

MRCA data are reported in 4-week intervals. Other data in the model are reported on a calendar-month basis. Thus, we had to convert the MRCA data (both prices and quantities) to a calendar-month basis. We used a simple allocation scheme. For example, total consumption in a week that overlapped 2 months was allocated to each month based on the number of days in the month that the week represented. We used the same method to estimate the proportion of households purchasing cheese in a given month. That is, we divided the total number of buying households in a month by the total number of households to calculate the proportion of buying households in a given month. We also adjusted the quantity data so that each calendar month reflected the same number of days, removing any artificial month-to-month seasonal patterns caused strictly by the fact that some months have more days than others. We similarly adjusted disposable income and monthly generic and branded advertising expenditures.

BLS provided the price index for meat, poultry, and fish and the CPI data. We obtained personal disposable income figures from the Bureau of Economic Analysis, U.S. Department of Commerce, and U.S. civilian population data from the Bureau of the Census, U.S. Department of Commerce.

One would expect the coefficient on the price of natural cheese to enter the natural models with a negative sign. One would also expect the coefficient on the price of processed cheese to be positively related to natural cheese sales because this commodity can be regarded as a substitute for natural cheese. The coefficient associated with the price index for meat, poultry, and fish cannot be predicted a priori because whether these commodities can be regarded as substitutes or complements for natural cheese is unclear. Income should have a positive effect on natural cheese usage.

We included Government donations in the model to capture their influence on retail sales. That is, one would expect donations to displace purchases by households receiving the donated cheese. Thus, we expected the sign on the coefficient associated with the donations variable to be negative.

We incorporated a time trend into the natural cheese models to capture the clear downward trend reflected in the MRCA data across years in the purchases of natural cheese for consumption at home. We also included a series of monthly dummy variables in the natural cheese models to capture the seasonal month-to-month variation in natural cheese purchases that the MRCA data reflect.

Except for the time trend, monthly dummy variables, and advertising expenditures, all other variables are logarithmically transformed. Preliminary analysis indicated that this functional specification provided a good fit to the data and coefficients of reasonable magnitude. Preliminary model specifications indicated that the coefficient associated with a time trend was not statistically significant in the processed cheese equation.

We expected, a priori, that the price of processed cheese would enter the processed cheese models with a negative sign, that the prices of natural and imitation cheese and income would enter with positive signs, and that Government cheese donations would be negatively related to processed cheese purchases.

Monthly branded advertising expenditures for cheese were supplied by the United Dairy Industry Association (UDIA). UDIA, the National Dairy Promotion and Research Board, and the California Milk Advisory Board supplied monthly generic promotion expenditures for real cheese. On advice from representatives of the National Dairy Board, 25 percent of these groups' calcium advertising expenditures were allocated to generic cheese promotion. Promotion expenditures for both branded and generic advertising represent only the media cost component of advertising. That is, promotion expenditures do not include such items as talent and production costs.

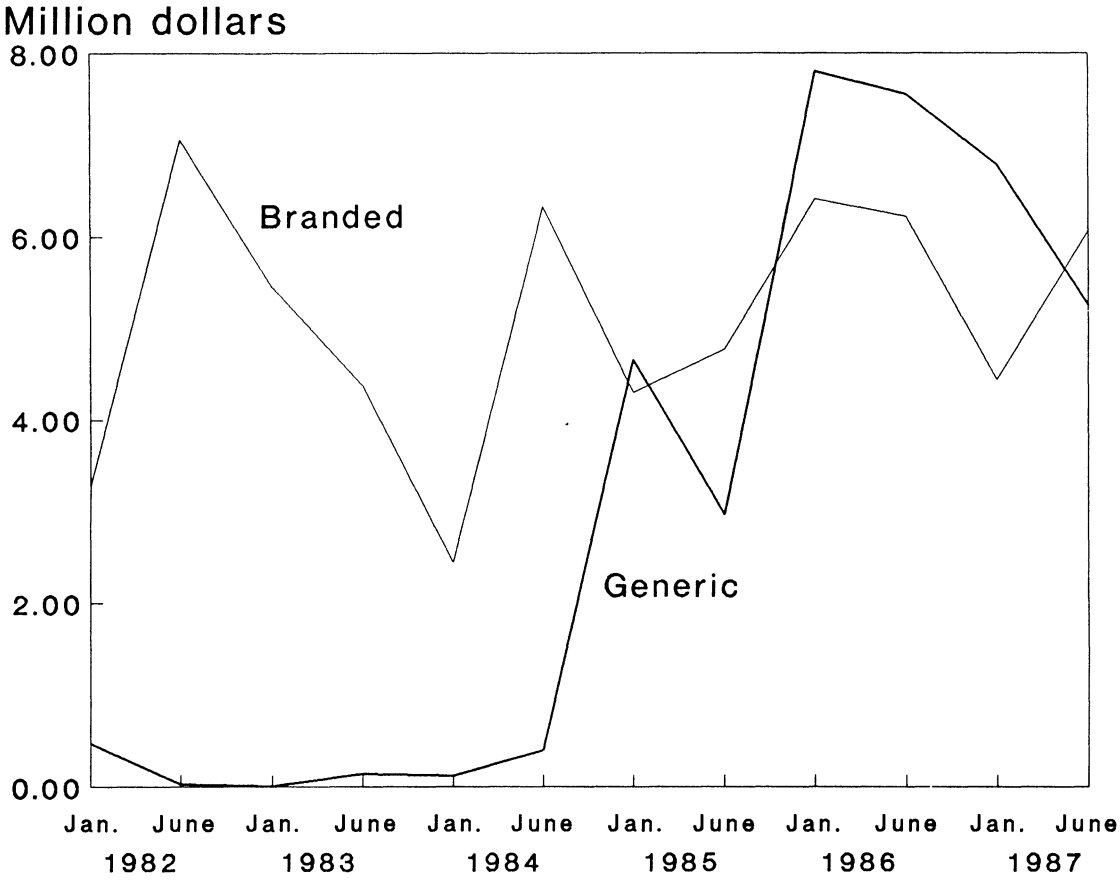
Generic advertising expenditures for cheese increased tenfold from 1982 to 1986 (table 1 and fig. 5). Branded advertising expenditures increased almost 50 percent from 1982 to 1984 before declining and then increasing again through June 1987. Both generic and branded advertising expenditures were deflated by separate media cost indexes, allowing advertising expenditures to be interpreted as a measure of the quantity of advertising taking place in each time period. Divisia advertising cost indexes were constructed which are exact for an underlying translogarithmic unit cost function. (For details in constructing this type of index, see Diewert, 1976, page 121.) We constructed the divisia indexes using information on the share of total advertising expenditures spent for each type of

Table 1--Estimated generic and branded advertising expenditures for cheese

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
Jan.-June 1987	35.2	33.6

Figure 5

Monthly generic and branded advertising expenditures



media and price indexes for each media type. 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.

We entered both generic and branded advertising expenditures into the model using an inverse functional form. We chose the inverse form because of the wide range of the advertising expenditure data, especially for generic promotion, and because of its other desirable characteristics.

Direct estimation of the parameters in each of the demand equations is not possible because of the nonlinearities due to the parameters of the gamma distribution. The estimation strategy was to set the parameters c, L, s, and H to fixed values and 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,

and H, and the equation yielding the best statistical fit with plausible parameter estimates was selected. Consequently, the standard errors for the parameters c, L, s, and H are not available. This estimation procedure will also bias the standard errors of other parameters in the model downward.

EMPIRICAL RESULTS OF THE DEMAND MODELS

Tables 2 and 3 present parameter estimates of the natural and processed cheese aggregate demand equations. Both equations provide a reasonably good statistical fit to the data and were estimated with the assumption of first-order autocorrelation. Most parameter estimates have the expected signs and are generally of a reasonable magnitude, but some of the estimates are not statistically significant at the usual confidence levels.

Table 2--Summary of natural cheese model estimates, January 1982-June 1987

Source	Estimated b values	T for H:b=0	Prob T	Standard error of estimate
Intercept	-7.31	-3.385	0.0015	2.160
log(pn)	-1.259	-3.906	.0003	.322
log(pp)	.739	2.586	.0130	.286
log(pm)	.836	7.557	.0001	.111
log(Y)	.845	3.155	.0029	.268
d	.009	1.149	.2567	.008
t	-.005	-5.430	.0001	.001
DJAN	-.133	-7.089	.0001	.019
DFEB	-.240	-8.311	.0001	.029
DMAR	-.155	-9.042	.0001	.017
DAPR	-.205	-12.705	.0001	.016
DMAY	-.215	-11.926	.0001	.018
DJUN	-.244	-13.818	.0001	.017
DJUL	-.254	-13.228	.0001	.019
DAUG	-.221	-10.079	.0001	.022
DSEP	-.217	-11.731	.0001	.018
DOCT	-.158	-7.917	.0001	.020
DNOV	-.131	-10.545	.0001	.012
advb	.066	1.265	.2124	.052
advg	-.001	-2.632	.0116	.0002
rho	-.229	-1.581	.1200	.145
c	.7			
L	.001			
s	.7			
H	.3			

Note: rho is the first-order autocorrelation coefficient.
Adjusted R^2 = 0.97
Number of observations = 66
Degrees of freedom = 45

We estimated the own-price elasticity for natural cheese to be about -1.3 in the demand equation. Thus, if the price of natural cheese rose by 10 percent, the quantity demanded of natural cheese would decline by about 13 percent. The own-price elasticity for processed cheese is estimated to be about -0.8, indicating that a 10-percent increase in price would cause about an 8-percent decrease in quantity purchased. Both own price variables are statistically significant at acceptable levels (greater than 5 percent). The income elasticities for natural and processed cheese are estimated to be about 0.8 and -0.05, respectively. Thus, natural cheese purchases are more responsive to income changes than processed cheese. The income elasticity for natural cheese is statistically significant at a level greater than 1 percent, but the income elasticity for processed cheese is not statistically different from zero. These elasticities indicate that a 10-percent increase in income would cause about a 9-percent increase in the quantity of natural cheese purchased and a 0.5-percent decrease in processed cheese purchases, other factors constant.

The estimated cross-price elasticities between quantities of natural cheese purchased and the prices of processed cheese and meat are 0.7 and 0.8. Both variables are statistically significant at the 1-percent level or better. The cross-price elasticities measure the extent that natural cheese purchases respond to a 1-percent change in the price of the substitute or complementary good, holding other factors constant. A positive cross-price elasticity indicates that two commodities are substitutes. A negative cross-price elasticity indicates that two commodities are complements. The estimated cross-price elasticities between processed cheese purchases and the prices of natural cheese, meat, and imitation cheese are about 0.01, 0.8, and 0.3. Of these cross-elasticities, the natural cheese coefficient is not statistically significant. However, the meat and imitation cheese coefficients are statistically significant at levels greater than 1 percent. The estimated coefficients for Government donations in the demand equation are 0.009 for natural cheese and -0.07 for processed cheese. The

Table 3--Summary of processed cheese estimates, January 1982 - June 1987

Source	Estimated b values	T for H:b=0	Prob T	Standard error of estimate
Intercept	-0.800	-0.781	0.4381	1.024
log(pn)	.014	.057	.9548	.252
log(pp)	-.781	-2.218	.0306	.352
log(pi)	.345	2.339	.0229	.147
log(pm)	.773	3.079	.0032	.251
log(Y)	-.052	-.413	.6811	.127
d	-.069	-4.293	.0001	.016
adv	-.341	-2.630	.0110	.130
rho	-.279	-2.175	.0001	.128
c	.1			
L	.9			

Note: rho is the first-order autocorrelation coefficient
Adjusted R^2 = 0.71
Number of observations = 66
Degrees of freedom = 57

donations coefficient in the natural cheese equation was not statistically significant. Thus, Government donations have a large negative effect on processed cheese purchases and are the most important variable for explaining quantities purchased in the processed cheese equation.

The monthly dummy variables in the natural cheese equation measure month-to-month differences in quantities purchased in relation to December's purchases, the base month. All monthly dummy variables are statistically significant at usual confidence levels and have negative signs. The negative signs indicate that purchases of natural cheese are higher in December than in other months. Monthly dummy variables were initially entered into the processed cheese equation. However, statistical tests indicated that as a group they were not significant. Next, we tried a dummy variable representing the summer months, but it was also insignificant.

The advertising constants, k's, in all equations were set equal to 0.0001. A small value for the parameter in relation to the magnitude of the advertising variable is necessary to avoid distorting the underlying relationship between advertising expenditures and the purchase behavior. This constant, k, represents a latent or unobserved component such as word-of-mouth advertising that would generally be expected to be small when compared with the direct effect. We tried smaller values of k, but results remained relatively constant. The value of k is particularly important for simulating the effects of promotion on sales, and determining its value remains a difficult empirical issue (see Kesecker and Wu, 1982, and Wu and Kesecker, 1985). Branded and generic advertising expenditures were initially entered separately in the processed cheese equation. This formulation consistently led to a deterioration of the model in terms of incorrect signs of the coefficients on the advertising variables, implying that advertising may have a negative effect on purchases. An examination of quarterly LNA data revealed that one company dominates the advertising of processed cheese products, and a high percentage of these promotion expenditures were for just a few products. Thus, in the case of processed cheese, it may be that branded advertising may function more nearly as a generic form of promotion than as branded form.

The estimated coefficient for the generic advertising variable has the correct sign in the natural cheese equation and is significant at the 1-percent level (table 2). The coefficient on the branded advertising variable has a positive sign but is not statistically significant, possibly suggesting that branded advertising may shift demand from natural cheese to processed cheese. The estimated parameters, c and L, in the natural cheese equation indicated that only generic advertising in the current month influences consumption (app. II). In other words, past advertising does not affect current consumption. Dropping the branded advertising variable from the model did not significantly improve the other parameter estimates.

The advertising (combined branded and generic) coefficient in the processed cheese equation had the correct sign and is statistically significant at the 1-percent level (table 3). The parameters c and L in the processed cheese equation imply that current period advertising most affects consumption, but the weights on past advertising expenditures decline slowly, with advertising expenditures 12 months ago having about 40 percent of the effect of current period advertising (app. II). This strong effect of past advertising expenditures may be somewhat implausible from an intuitive standpoint, although there is no theoretical evidence on the length of the advertising carryover effect, if indeed there is any at all.

Over the period of study, the real prices of both processed and natural cheeses generally declined. At the same time, per capita income rose steadily in nominal dollars, from about $9,600 to about $13,000 per year (fig. 6). Our models show that only consumption of natural cheese is sensitive to income changes, but consumption of both natural and processed cheese changes as prices change.

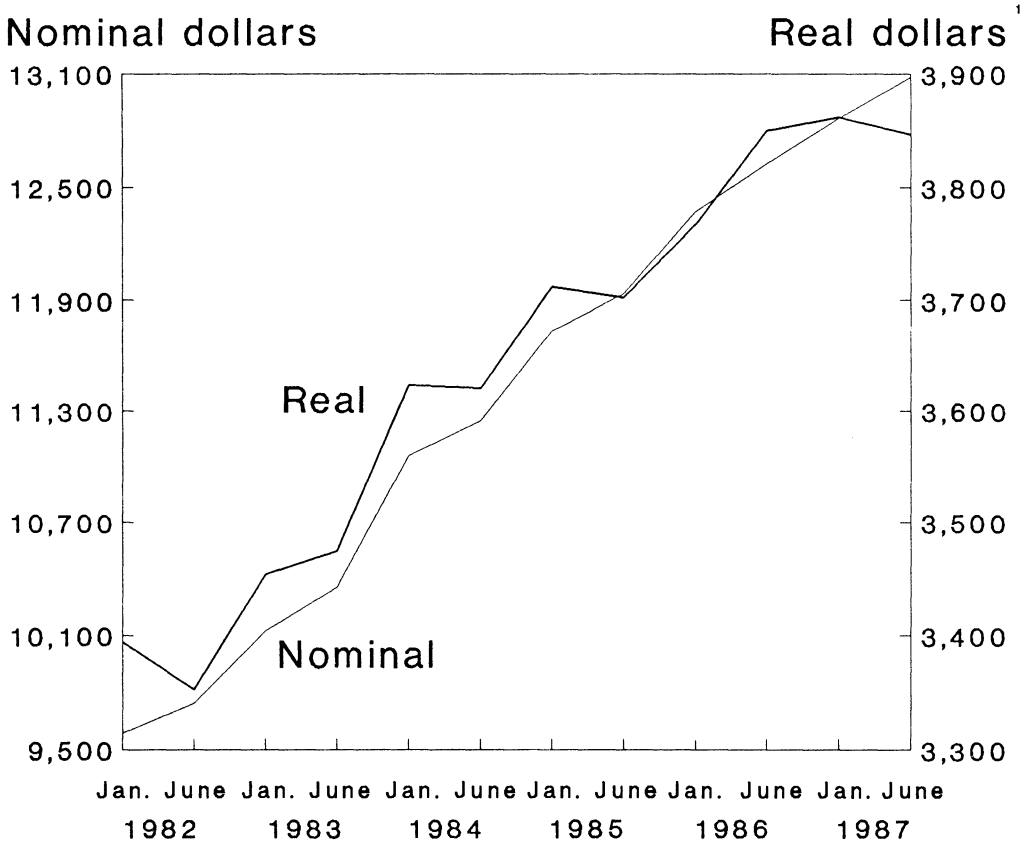
Much of the increase in total cheese consumption is probably due to more eating away from home. Pizza, usually consumed away from home, is a favorite meal of American households, and consumption of food away from home is highly income elastic.

SIMULATIONS OF THE DEMAND EQUATIONS

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

Figure 6

Per capita income



[1] Real dollars determined by deflating nominal dollars by the Consumer Price Index (1967=100).

used the following procedures to simulate the effect on cheese purchases of increased generic advertising after passage of the Dairy and Tobacco Adjustment Act of 1983, which created the National Dairy Promotion and Research Board and mandatory checkoff program. First, we simulated per person consumption from the natural and processed cheese equations using the actual levels of generic advertising. Next, we simulated per person consumption assuming that generic advertising remained at the monthly per capita levels of the year prior to the initiation of the Dairy Board, September 1983 through 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 over the period September 1984 through June 1987. 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 person consumption between the simulations is an estimate of the effect of the act. We then obtained the national effect of the act by expanding the per person effect by total population (table 4).

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.

Table 4--Summary of model simulation results on the effect of regional and national generic cheese advertising on national at-home consumption, September 1984-June 1987

Item	Unit	Sales/advertising results
Total sales of natural cheese	Million lbs	3,200.3
Total sales of processed cheese	do.	2,103.3
Estimated increase in national and regional advertising expenditures due to DTAA	Million dollars	1/145.6
Natural cheese:		
Sales gain due to advertising	Million lbs	16.0
As a share of total sales	Percent	.5
Per advertising dollar	Lbs	.1
Processed cheese:		
Sales gain due to advertising	Million lbs	98.4
As a share of total sales	Percent	4.7
Per advertising dollar	Lbs	.7

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

Results of the simulations indicate that the increased generic advertising expenditures due to enactment of the act increased national consumption of natural cheese at home by 10-22 million pounds (table 4). These estimates were derived by evaluating the natural cheese model at the coefficient on generic advertising, plus and minus one standard error. The midpoint estimate is 16 million pounds. In contrast, the MRCA data indicate that during September 1984-June 1987, total national consumption of natural cheese at home was 3.2 billion pounds. Similar estimates from the processed cheese model indicate that increased generic advertising caused by creation of the National Dairy Board increased national consumption of processed cheese at home by 65.5-126.4 million pounds. The midpoint estimate is 98.4 million pounds. 2/ The MRCA data indicate that total national consumption of processed cheese at home during September 1984-June 1987 was 2.1 billion pounds.

Generic advertising appears to be much more effective in increasing total consumption in the processed cheese equation because of the sustained effect of past advertising on current consumption.

We also performed simulations to estimate the effect of increasing real generic advertising expenditures by 5 percent above the actual amount spent during September 1984-June 1987. These results indicate that a 5-percent increase in generic advertising expenditures for cheese would have virtually no effect on natural cheese consumption. This increase in advertising expenditures, however, would have increased processed cheese consumption by 3.9 million pounds.

Similar procedures were used to simulate the effect on cheese purchases of changes in other model variables. First, we simulated per person consumption from the natural and processed cheese equations using the actual levels of all variables. Next, we simulated per person consumption assuming that the variable of interest, say natural cheese prices, remained at the monthly levels of the year prior to the initiation of the Dairy Board, September 1983 through 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 person consumption between the simulations is an estimate of the effect of changes in an individual variable. We then obtained the national effect by multiplying the per person effect by the total population (table 5).

Falling real natural cheese prices, down 4.7 percent on average from September 1983-August 1984 to September 1984-June 1987, increased natural cheese sales by about 189 million pounds, all other variables constant. This change in natural cheese prices decreased processed cheese sales by about 15 million pounds because natural and processed cheeses are substitutes. A 3.9-percent decline in real processed cheese prices between these periods increased processed sales by 63 million pounds. A 3.2-percent drop in real prices of meat, poultry, and fish decreased natural cheese sales by 92 million pounds and processed cheese sales by 56 million pounds. Rising real consumer income, up 4.7 percent, increased natural cheese sales approximately 123 million pounds but had a small negative effect on processed cheese sales. Declining levels of per person cheese donations between the simulation periods helped boost processed sales by 18 million pounds.

2/ We estimated a processed cheese model identical to the one described here, except that for advertising we assumed a 12-month polynomial lag structure with both end points equal to zero. This model produced simulation results similar to those reported for the gamma model.

ENTRY AND EXIT EQUATIONS

Parameter estimates of the entry and exit curves for natural cheese are found in tables 6 and 7. In the equation for the proportion of all households purchasing natural cheese, all variables have the expected sign, and most are significant at the 5-percent level or greater. Specifically, a 10-percent increase in the price of natural cheese decreased the proportion of all households in the market by about 5 percent. A 10-percent increase in the price of processed cheese increased the proportion of households purchasing natural cheese by about 7 percent. An increase in the CPI for meats increased the proportion of households entering the natural cheese market by about 5 percent.

The income and donations variables were not statistically significant. All dummy variables were statistically significant and negative except the one for February, which was positive and insignificant, and November, which was negative and insignificant.

We found that the generic advertising variable was statistically significant at a level greater than 1 percent, and that it had the correct sign. However, the branded advertising coefficient was statistically insignificant although it had the expected sign. The three most important variables affecting the proportion of households entering the natural cheese market, other than dummy variables, in terms of statistical tests, were the CPI for meat, the price of processed cheese, and generic advertising.

In the average quantity purchased equation, the price of natural cheese, the trend, the CPI for meats, income, and the dummy variables were statistically significant. Neither advertising variable increased the average quantity of cheese bought by households already in the cheese market. Hence, advertising

Table 5--Summary of model simulation results on the effect of changes in selected variables on consumption of natural and processed cheese at home, September 1984-June 1987

Item	Sales results
Natural cheese:	Million pounds
Sales gain or loss due to changes in selected variables--	
Price of natural cheese	189.2
Price of processed cheese	-93.9
Price of meat, poultry, and fish	-92.4
Income	123.3
Processed cheese:	
Sales gain or loss due to changes in selected variables--	
Price of natural cheese	-14.9
Price of processed cheese	63.0
Price of meat, poultry, and fish	-56.4
Income	-5.2
Donations	18.0

apparently induces households to enter the market but not to increase the average quantity of their purchases.

Of the significant variables, a 10-percent increase in the price of natural cheese decreased the average amount purchased by approximately 9 percent. A 10-percent increase in the CPI for meats increased natural cheese purchases by purchasing households by about 5 percent, and a 10-percent increase in income increased average purchases by about 6 percent, other factors constant.

Results for the entry and exit equations for processed cheese are in tables 8 and 9. In the equation for the proportion of households purchasing processed cheese, the price of processed cheese variable had the wrong sign and was statistically insignificant. The price of the natural cheese variable had the expected sign but it was also insignificant. However, the price of imitation cheese variable was

Table 6--Estimates of the proportion of households purchasing natural cheese, January 1982-June 1987

Source	Estimated b values	T for H:b=0	Prob T	Standard error of estimate
Intercept	1.913	1.213	0.2313	1.5766
log(pn)	-.530	-2.047	.0465	.2590
log(pp)	.651	3.228	.0023	.2019
log(pm)	.469	4.942	.0001	.0950
log(Y)	.299	1.530	.1330	.1957
d	-.007	-1.314	.1955	.0052
t	-.002	-2.602	.0125	.0008
DJAN	-.062	-4.403	.0001	.0142
DFEB	.006	.318	.7522	.0199
DMAR	-.064	-5.004	.0001	.0127
DAPR	-.047	-4.283	.0001	.0111
DMAY	-.104	-7.564	.0001	.0137
DJUN	-.085	-6.794	.0001	.0125
DJUL	-.125	-8.831	.0001	.0142
DAUG	-.105	-6.417	.0001	.0164
DSEP	-.057	-4.392	.0001	.0131
DOCT	-.065	-4.180	.0001	.0155
DNOV	-.004	-.438	.6635	.0090
advb	-.009	-.875	.3864	.0107
advg	-.0004	-3.178	.0027	.0027
c	.7			
L	.001			
s	.7			
H	.3			

Adjusted R^2 = 0.97
Number of observations = 66
Degrees of freedom = 45

significant at a level greater than 1 percent and had the expected sign. A 10-percent increase in the price of imitation cheese would increase the proportion of households entering the market for processed cheese by about 4 percent.

The CPI for meats, income, and donations had the expected signs and were significant at levels greater than 1 percent. Hence, a 10-percent increase in the CPI for meats would increase the proportion of households in the processed cheese market by about 4 percent, while a similar increase in income would increase the proportion by about 9 percent. Advertising had the wrong sign in this equation and was not statistically significant.

Table 7--Estimates of the average quantity of natural cheese purchased by purchasing households, January 1982-June 1987

Source	Estimated b values	T for H:b=0	Prob T	Standard error of estimate
Intercept	-5.357	-2.575	0.0134	2.0803
log(pn)	-.875	-2.890	.0059	.3028
log(pp)	.147	.558	.5759	.2639
log(pm)	.452	4.044	.0002	.1118
log(Y)	.638	2.479	.0170	.2575
d	.009	1.141	.2599	.0078
t	-.003	-3.777	.0005	.0009
DJAN	-.062	-3.564	.0009	.0173
DFEB	-.141	-5.056	.0001	.0279
DMAR	-.083	-5.150	.0001	.0161
DAPR	-.123	-7.953	.0001	.0154
DMAY	-.105	-6.210	.0001	.0170
DJUN	-.124	-7.448	.0001	.0167
DJUL	-.125	-6.935	.0001	.0181
DAUG	-.110	-5.350	.0001	.0205
DSEP	-.123	-7.053	.0001	.0175
DOCT	-.086	-4.653	.0001	.0186
DNOV	-.093	-8.090	.0001	.0115
advb	.035	.357	.7230	.0981
advg	-.0001	-.288	.7744	.0002
c	.7			
L	.001			
s	.7			
H	.3			

Adjusted R^2 = 0.90
Number of observations = 66
Degrees of freedom = 45

In the equation for the average quantity bought by households in the processed cheese market, the variable for the price of processed cheese had the correct sign and was significant at a level greater than 1 percent (table 9). However, the prices of natural and imitation cheese, donations, and income were insignificant. The CPI for meats and the advertising variable were significant at a level greater than 1 percent.

Table 8--Estimates of the proportion of households purchasing processed cheese, January 1982-June 1987

Source	Estimated b values	T for H:b=0	Prob T	Standard error of estimate
Intercept	-3.419	-4.029	0.0002	0.8486
log(pn)	.023	.115	.9089	.2001
log(pp)	.363	1.331	.1885	.2726
log(pi)	.381	3.533	.0008	.1079
log(pm)	.381	2.282	.0262	.1669
log(Y)	.931	8.720	.0001	.1067
d	-.729	-7.645	.0001	.0954
advb	.130	.861	.3931	.1514
c	.1			
L	.9			

Adjusted R^2 = 0.81
Number of observations = 66
Degrees of freedom = 57

Table 9--Estimates of the average quantity of processed cheese purchased by purchasing households, January 1982-June 1987

Source	Estimated b values	T for H:b=0	Prob T	Standard error of estimate
Intercept	-0.062	-0.114	0.9094	0.5381
log(pn)	.167	1.245	.2183	.1342
log(pp)	-.725	-3.846	.0003	.1885
log(pi)	.109	1.350	.1825	.0806
log(pm)	.368	2.833	.0064	.1300
log(Y)	-.041	-.605	.5475	.0670
d	-.096	-1.224	.2262	.0781
advb	-.155	-2.957	.0045	.0524
c	.1			
L	.9			

Adjusted R^2 = 0.52
Number of observations = 66
Degrees of freedom = 57

The advertising variable in the average quantity purchased equation was statistically significant at a level greater than 1 percent. Advertising apparently increases the amount of average purchases made by households in the processed cheese market but does not induce entry into the market. Entry apparently depends upon the price of processed cheese, the price of meats, and the level of advertising.

STUDY LIMITATIONS

Several factors limit the conclusions that can be drawn from this study. First, MRCA data only measure household purchases of cheese at retail establishments for offpremise consumption. Cheese consumed away from home or as a component of a food product is not measured by MRCA. USDA per capita disappearance data suggest that cheese use has increased over time, but the MRCA data show it declining. This contradiction suggests that the downward trend in purchases for consumption at home is more than offset by growth in eating away from home and the consumption of cheese in food mixtures. Generic advertising may affect consumption of cheese away from home and food mixtures that contain cheese which are not measured with the MRCA data. Thus, our estimates may understate the total effect of generic advertising.

Another limitation of the current analysis is the relatively short time that the National Dairy Board has been advertising cheese. In September 1984, when the National Dairy Board began advertising cheese, the absolute amount of generic advertising expenditures for cheese rose dramatically. For example, in September 1984 about $4 million was spent on generic cheese promotion compared with less than $900,000 in September 1983.

Because advertising campaigns require time before cumulative results can be seen, a longer time series will be necessary to measure the effects of advertising with a higher degree of statistical accuracy unless one can impose prior information on the dynamic structure of the advertising-sales relationship. The length of the carryover effect of advertising on sales (as found in our processed cheese model) suggests that the MRCA data series may be too short to measure both the dynamic structure and the aggregate effect of advertising on sales.

Another area that requires attention is branded advertising expenditures. The cheese market appears to be unique in that one firm apparently dominates branded advertising. At times, a large share of the reported branded advertising expenditures is for only a couple of products. The issue concerns how to treat branded advertising in econometric models of cheese demand when a single firm dominates the at-home market. Whether branded advertising should be modeled separately from generic advertising or treated as a form of generic advertising is an area for further research.

The issue of how to best model the effect 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 I: AVAILABLE DATA SETS

MRCA Data. The MRCA data are derived from a nationwide mail diary panel of 7,500 households. Participants represent a wide variety of different demographic and geographic profiles, including race, age and marital status of household members, number of children, and the location of the household. The panel has been maintained continuously over time, with appropriate new households added when existing households leave the sample. MRCA compensates all households.

Panelists record information when they purchase a product that is in one of the diary's product categories. These categories include food and beverages, health items, and other personal products. The information recorded includes the brand name, type of item, size or amount purchased, price, type of store, and whether or not the item was the object of a sales promotion. Panelists also record universal price code (UPC) bar codes when applicable. MRCA then uses these codes to verify the accuracy of the panelist's diary.

Households mail a diary to MRCA once each week. MRCA then compiles the data and makes the compilation available to clients. These data are intended to answer such questions as what brands of a product are purchased by buyers; what effect sales incentives have on purchases; are trial buyers making repeat purchases; and what are the demographic profiles of buyers of a specific product? The National Dairy Board supplied the MRCA data used in this study.

USDA Consumption Data. The sum of production, beginning stocks, and imports constitutes the supply available for use. "Use" means exports, food and nonfood use, and ending stocks. Some of these categories may be further broken down, depending on the commodity and the particular use of the commodity. For example, use for food, called food "disappearance," is often separated into military and civilian disappearance; stocks may include commercial and Government holdings. Civilian disappearance divided by civilian population yields per capita civilian disappearance or per capita civilian consumption. In most cases, food disappearance is the residual after accounting for production, stock changes, and net trade. The supply side of the ledger, therefore, will always balance with the utilization side.

BLS's Continuing Consumer Expenditure Survey (CCES). An annual survey, the CCES contains the most recent (1980-85) and comprehensive data available on food spending in American households. The CCES records only items that households purchased for use at home during the survey period. For example, if a household only consumed food already in stock and purchased no foods, the household expenditure for food was zero. For the entire 1980-85 period, the CCES contains data on urban households. The CCES includes two components, each with its own questionnaire and sample: an interview panel that surveyed about 5,000 households every 3 months over a 1-year period, and a diary survey also of about 5,000 households. In the interview survey, households kept an expenditure record for relatively large and infrequently purchased items, such as those for real property, automobiles, and major appliances that they could recall over a 3-month period.

In contrast, the diary survey obtained data for small, frequently purchased items that are normally difficult to recall, such as foods, beverages, tobacco, housekeeping supplies, nonprescription drugs, personal care products, services, and fuels. The diary survey excludes expenditures incurred when members of a household were away from home overnight or a longer period of time.

APPENDIX II: CALCULATED WEIGHTS FOR GAMMA DISTRIBUTED LAGS

The effect of past advertising expenditures on current consumption is strongly influenced by the parameters of the gamma distribution. The following table lists the weight of past influences on present consumption that are associated with selected parameters of the gamma distribution.

Month of advertising	Parameters (c,L)		
	(0.7,.001)	(0.7,.3)	(0.1,.9)
Current month	1.0	1.0	1.0
1 month ago	.05	1.512	.972
2 months ago	.0013	1.168	.915
3 months ago	0	.686	.850
4 months ago	0	.346	.785
5 months ago	0	.159	.721
6 months ago	0	.068	.659
7 months ago	0	.028	.603
8 months ago	0	.011	.550
9 months ago	0	.004	.500
10 months ago	0	.002	.455
11 months ago	0	.001	.414
12 months ago	0	0	.396

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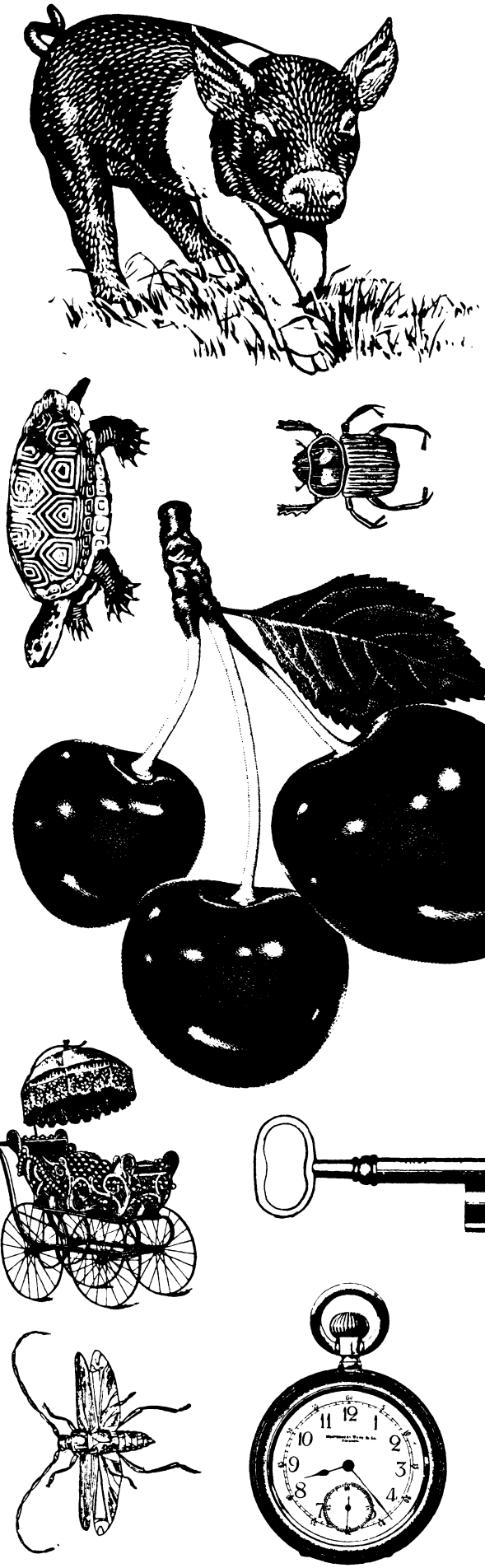

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