Economic Evaluation of Commodity Promotion Programs in the Current Legal and Political Environment

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An Economic Analysis of Generic Egg Advertising in California, 1985-1995

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Introduction

Since 1984, the California Egg Commission (CEC) has financed egg advertising, promotion, education, and research aimed at increasing egg consumption and enhancing returns for California egg producers. California is the largest egg producing state in the nation, with over 25 million laying hens producing more than six billion eggs per year -- approximately 10 percent of the national total. The CEC generates revenues for operation of their programs by assessing egg producers 1¢ per dozen shell eggs sold within the state.[1] The CEC assessment and marketing program operates completely independent of the national program operated by the American Egg Board (AEB). As such, any assessments levied on California producers or handlers are in addition to assessments at the national level.[2] Eggs sold outside of the state, exported, consumed by the military, or transported to breaking plants within the state for further processing are exempt from assessments under the CEC.

The CEC has an annual budget of about $4 million. Approximately 90 percent of this budget is directed towards advertising, public relations, promotion, education, and research purposes, with media advertising comprising the largest share. Annual expenditures for advertising have consistently been over $3 million, with approximately 80 percent in the form of media advertising and the remaining

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[1] Producers handling less than 26,000 cases of eggs (or liquid equivalent) per year are exempt from the assessment. There are currently 19 exempt handlers, but their combined marketings constitute less than 2 percent of the total volume handled. Starting in 1993, separate assessments were also levied on distributors of eggs and egg products produced outside of the state and imported within California. Assessments on egg products are based on a 38 pound liquid equivalent weight of 30 dozen eggs (one case) and is currently at 7¢ per case, with a mandatory limit of 30¢. The CEC producer assessment currently averages approximately 2 percent of farm prices.

[2] Since February 1995, producers with more than 75,000 laying hens pay a mandatory national assessment of 10¢ per 30 dozen case. Prior to this, the assessment was 5¢ and applied to producers with more than 30,000 laying hens.

20 percent corresponding to the production costs of advertising. Since 1985, CEC advertising expenditures have totaled more than $37 million.

Figure 1 displays per capita egg consumption in California from 1985 to 1995. Between 1985 and mid-1995, quarterly consumption of eggs and egg products dropped from 66 eggs to 48 eggs, but has increased since then to its current level of nearly 54 eggs. This represents an 18 percent decrease in consumption and compares to a decrease at the national level of approximately 10 percent. The downward trend in the demand for eggs has been attributed to the abundance of information surrounding heart disease and cholesterol intake. For this reason, much of the past generic advertising has been developed under a defensive strategy to counter negative publicity. However, current advertising efforts are directed towards convenience and the nutritional value of eggs in a well-balanced diet. Relative to consumption, producer prices have been much more variable. As Figure 2 indicates, real producer prices for eggs have generally trended downward over this period, even though prices reversed the trend in late 1988, and actually increased in 1990. After 1990, prices have trended downward, with a slight increase in both prices and consumption since late 1994.

Figure 1. Quarterly California Egg Consumption Per Capita

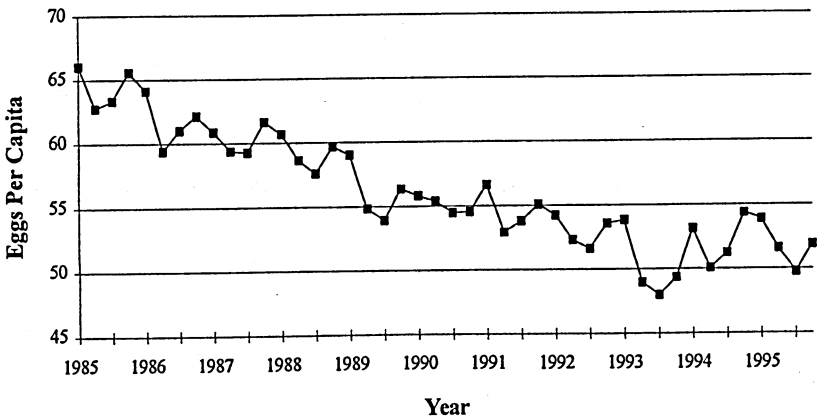
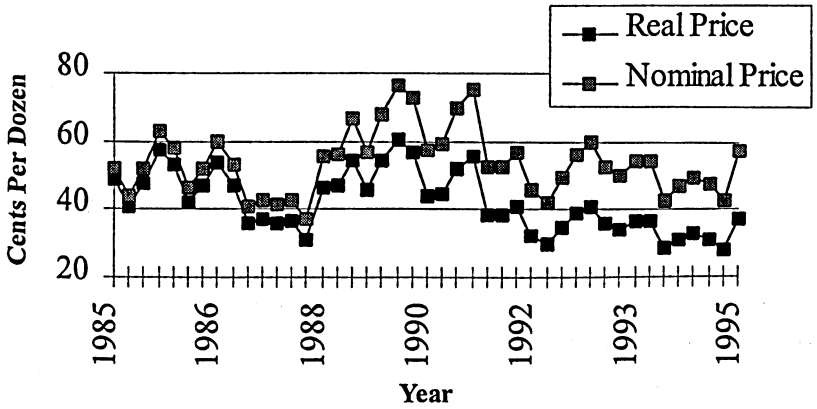


Figure 2. California Producer Egg Prices, 1985 -1995



Given the slow, yet steady, decline in per capita egg consumption and producer prices, an evaluation of the effectiveness of generic egg promotion in California is both timely and important. Accordingly, the purpose of this study is to measure the impact of generic egg advertising in California on producer prices and net revenue over the period 1985 to 1995. To measure these impacts, an econometric model describing the supply and demand for California eggs was estimated. The estimated model was then used to simulate the impact of two advertising scenarios on producer prices, production, and net revenues for the 1985 through 1995 period. In the first scenario generic egg advertising expenditures were set equal to historical levels, while in the second scenario expenditures were increased by 1 percent. Based on the simulation results, the marginal rate of return to advertising expenditures (i.e., benefits to costs of additional generic advertising) was computed.

Previous Research

While various egg price forecasting and egg industry models were common in the 1970s and 1980s (e.g., Miller and Masters, 1973; Roy and Johnson, 1973; Schrader, et al., 1978; Salathe, et al., 1983; Chavas and Johnson, 1981; and Blaylock and Burbee, 1985), little research has focused on the impact of generic advertising on farm-level prices and per capita consumption. Chavas and Johnson (1981) provided the most detailed model of the egg industry in the literature,

encompassing estimation of production, consumption, and storage components. Brown and Schrader (1990) estimated an econometric model for the egg industry and found that information on the links between cholesterol and heart disease had a significant negative impact on consumer demand for eggs. However, the effectiveness of generic advertising to maintain consumption levels was not addressed in either of these studies.

Generic egg advertising has been studied more recently by McCutcheon and Goddard (1992), and Chyc and Goddard (1994); however, these studies dealt with the Canadian supply-managed egg sector where imports and egg production are restricted to maintain producer prices. Although evaluation of advertising in light of government intervention is more problematic, both studies were able to determine that generic egg advertising had a positive impact on demand.

The only recent study to examine generic egg advertising impacts in the United States was Reberte, Schmit, and Kaiser (1996), who estimated a comprehensive model of the U.S. egg sector, including production and consumption equations for both whole and processed egg products. Although similar in form to Chavas and Johnson, the model incorporated national AEB advertising expenditures since 1990. Advertising was shown to significantly influence farm prices and ultimately producer net revenues.

The Conceptual Model

The production of eggs is a fairly straightforward process. Approximately five months after the initial placement of chicks into the hatchery supply flock, hens are released into the laying flock. The laying process lasts from 12 to 14 months when the hens are either slaughtered or force molted. In the latter case, the hens receive a two month rest before resuming the laying cycle in the production flock. Therefore, the following variables are specified as determinants of California egg production:

$$(1) \quad PROD = f(PEGG_{-1}, FEED_{-1}, LAY, PTVTY, QTR1, QTR2, QTR3, TIME) \ ,$$

where *PROD* is the production of eggs in California, $PEGG_{-1}$ is the real producer

price for large eggs in Southern California lagged one quarter[3], $FEED_{-1}$ is the real feed price in Southern California lagged one quarter, *LAY* is a four quarter moving average of the size of the California laying flock, *PTVTY* is the average layer productivity for the quarter, *QTR1, QTR2,* and *QTR3* are quarterly dummy variables to account for seasonal variation in supply, and *TIME* is a time trend as a proxy for structural change. Lagged producer prices reflect a delay in farmers' production response to a current change in price. Feed costs are for "typical" feed at delivered net prices in Southern California.[4] Egg prices and production costs were obtained from the CEC for the time period evaluated (Bell, 1996).

The demand for California eggs is modeled in price dependent form and includes the following variables: farm egg demand, income, price of substitutes, generic advertising, a time trend, three quarterly dummy variables, and the percentage of women in the labor force. The level of farm egg demand should be negatively related to egg prices, while consumer income, price of egg substitutes, and generic advertising should be positively related to egg prices. The price of egg substitutes is represented in the model by a composite retail price index for meat in the western region. The time trend is included to represent changes in consumers' tastes and preferences for eggs over the last ten years.[5]

Similar to Reberte, Schmit, and Kaiser (1996), and Brown and Schrader (1990), the percentage of women in the labor force was included in the demand equation. Conflicting views exist regarding the relationship of this variable with egg consumption. On one hand, Stillman (1987) suggests a negative relationship since with more women working outside the home, less time is available to prepare

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[3]All monetary measures (except advertising expenditures) in the supply and demand equations were deflated by the consumer price index for the western region of the United States (1982-84=100). Generic advertising expenditures were deflated by the media cost Index provided by Leo Burnett Media.

[4]"Typical" refers to a feed mixture of corn and soybean meal in approximately a 85/15 blend ratio. Feed price is measured in real dollars per hundred-weight ($/cwt.).

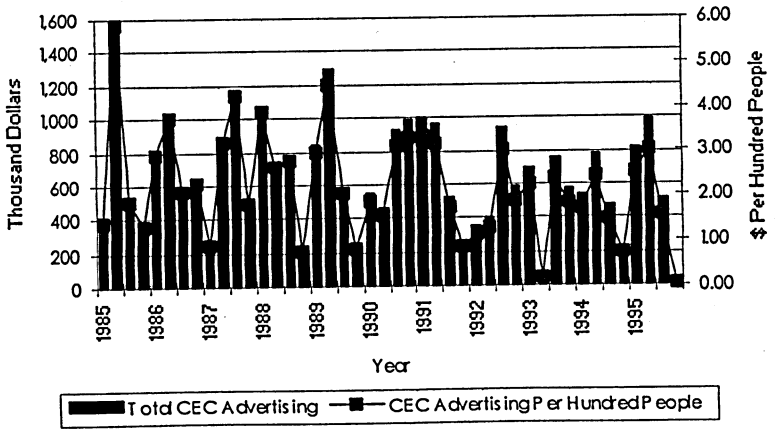
[5]Consumer demand is included as an identity in the model as farm production less net exports. This allows the use of producer price levels in both equations and production defined as farm-level demand.

eggs for breakfast. On the other hand, Brown and Schrader (1990) assert that as the number of working women increases, so does the number of breakfasts eaten away from home, which may increase overall egg consumption.

Following virtually every previous empirical study on generic advertising evaluations, the advertising effort was measured in terms of advertising expenditures. As mentioned earlier, the AEB advertising and promotion program operates independently of CEC advertising efforts. AEB and CEC advertising expenditures were converted to a per capita basis and then added to account for all advertising in California. Although actual per capita advertising expenditures may be higher or lower in California than at the national level, the approach followed here should provide a reasonable approximation. Average quarterly advertising expenditures in California per 100 people from 1985 to 1995 were $2.46. Of this amount, $2.31 -- nearly 94 percent -- was obtained from CEC expenditures. Both total and per capita CEC advertising expenditures are detailed in Figure 3.

Two cholesterol indexes were separately included in preliminary estimations, however neither was incorporated into the final specification due to poor performance and unexpected signs. The first index was constructed by Ward (1992) based on national survey data, and measures the percentage of consumers expressing strong or moderate concern about cholesterol in their diets. The second

Figure 3. Real CEC Advertising Expenditures, by Quarter 1985 - 1995



index was constructed similar to the one in McGuirk, et al. (1995), and measures the number of articles dealing with dietary cholesterol issues in national publications.[6] Both Brown and Schrader (1990), and McGuirk, et al. (1995) found a negative and significant relationship between cholesterol "concern" and consumption of eggs and meat, respectively. However, both studies were evaluated from the late 1960s to the late 1980s, a time period which demonstrated a definitive increase in dietary cholesterol concern, and ended prior to the decline in concern as distinguished in both the Ward survey index and publication index developed for this study. Both indexes suggest relatively low awareness in the mid-1980s, peaking in the late-1980s and early-1990s, and decreasing steadily since. To the extent that dietary cholesterol concern can be viewed as a structural change in the demand for eggs, its impact should be captured by the time trend.

Based on the above discussion, the farm level demand for eggs in California was modeled as the following equation:

$$(2)\quad PEGG = g(PROD, PMEAT, INC, ADV, QTR1, QTR2, QTR3, TIME, WOMEN)\ ,$$

where *PEGG* is the real producer price for large eggs in Southern California, *PROD* is farm-level production in California available for state consumption and net exports,[7] *PMEAT* is the real retail price index for meat in the western region of the U.S., *INC* represents real disposable income per capita in California, *ADV* represents per capita generic egg advertising expenditures in California, *QTR1*, *QTR2*, and *QTR3* are quarterly dummy variables to account for seasonal variation, *TIME* is a time trend, and *WOMEN* is the percentage of women employed in the labor force.

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[6]The publication index was constructed by counting the number of articles each month regarding nutritional impacts of dietary cholesterol reported in the *Reader's Guide to Periodical Literature* from 1985 through 1995. The index was weighted by the circulation levels of the various magazines and converted to a quarterly basis for inclusion in the model.

[7]Consumer demand is represented by the civilian disappearance of eggs (production + imports - exports - military use) as calculated and provided by the CEC and is included as an identity in the model such that total supply equals total demand either through civilian consumption or net exports and military use.

Econometric Results

Both the supply and demand equations were specified on a per capita basis, using a double log functional form (Table 1). The model was estimated using quarterly data from 1985 through June 1995. The procedure suggested by Godfrey (pp. 116-117) was used to test for autocorrelation. This procedure requires first obtaining each equation's vector of residuals and then re-estimating the model including in each equation the lagged residual as an additional regressor. The null hypothesis of no autocorrelation for a given equation is rejected if the coefficient on the lagged residual is significant based on a t-test. This procedure indicated that the residuals of both the supply and demand equations exhibited first-order autocorrelation. Autocorrelation correction procedures were subsequently used to estimate these equations.

The supply equation explained over 90 percent of the variation in production and all variables had expected signs. As expected, a positive relationship existed between producer prices and production; however, the own-price elasticity of supply was relatively low (0.009). This finding may not be surprising given the biological and economic constraints that limit production adjustments (Salathe, et al., 1983). Layer number and productivity were also found to have a positive effect on production (elasticities of 0.61 and 0.73, respectively). Lagged feed prices were negatively related to production and exhibited a fairly inelastic response (-0.04). The negative signs on the three seasonal dummy variables suggested production was highest in the fourth quarter. Finally, given the steady decline in per capita production over the time period evaluated, the negative trend variable was not unexpected.

Variables in the demand equation explained 86 percent of the variation in producer prices and all variables had expected signs. The results indicate an elastic response to price of approximately -1.7 (reciprocal of the price flexibility

Table 1. California Supply and Demand Specification Results

Supply Equation:

$$\ln(\text{PROD/POP}) = -9.174 + 0.009\ \ln(\text{PEGG})_{-1} - 0.035\ \ln(\text{FEED})_{-1} + 0.610\ \ln(\text{LAY})$$
$$(-1.76) \quad (0.28) \qquad\qquad (-0.54) \qquad (2.12)$$

$$+ 0.729\ \ln(\text{PTVTY}) - 0.017\ \text{QTR1} - 0.035\ \text{QTR2} - 0.025\ \text{QTR3} - 0.008\ \text{TIME}$$
$$(6.78) \qquad\qquad (-2.63) \qquad (-4.80) \qquad (-3.71) \qquad (-3.01)$$

$$R^2 = 0.94 \qquad\qquad \rho_1 = -0.617 \quad (-4.22)$$

Demand Equation:

$$\ln(\text{PEGG}) = -170.678 - 0.579\ \ln(\text{PROD/POP}) + 5.019\ \ln(\text{PMEAT})$$
$$(-4.78) \quad (-1.23) \qquad\qquad (4.67)$$

$$+ 14.149\ \ln(\text{INC}) - 0.007\ \text{QTR1} - 0.201\ \text{QTR2} - 0.118\ \text{QTR3} - 1.246\ \ln(\text{TIME})$$
$$(4.97) \quad (-0.23) \qquad (-4.37) \qquad (-3.56) \qquad\qquad (-5.17)$$

$$+ 1.387\ \ln(\text{WOMEN}) + 0.026\ \ln(\text{ADV/POP}) + 0.038\ \ln(\text{ADV/POP})_{-1}$$
$$(2.27) \qquad\qquad (1.76) \qquad\qquad (1.76)$$

$$+ 0.038\ \ln(\text{ADV/POP})_{-2} + 0.026\ \ln(\text{ADV/POP})_{-3}$$
$$(1.76) \qquad\qquad (1.76)$$

$$R^2 = 0.86 \qquad\qquad \rho_1 = 0.416 \quad (1.95)$$

Consumption Identity:

$$\text{CON} = \text{PROD} + \text{IMPORT} + \text{INTRA} + \text{GENERIC} - \text{TOTEXEGG} - \text{EGGBREAK}$$

Note: POP is the average quarterly state population, t-ratios are in parentheses, and ρ represents the autoregressive parameters. IMPORT = imported eggs, INTRA = intra-state breakers, GENERIC = generic egg product imports, TOTEXEGG = total exempt exported eggs, and EGGBREAK = eggs to breakers. Production, consumption, egg price, production cost, disposable income, and advertising expenditure data were provided by the CEC. PMEAT and WOMEN were obtained from the US Dept. of Labor, Bureau of Labor Statistics, On-line Computer File WWW, Washington, DC, 1985-1995.

coefficient). This result differs from the results of two earlier studies by Brown and Schrader (1990), and Chavas and Johnson (1981), who calculated price elasticities of -0.17 and -0.34, respectively. The more elastic results, while somewhat surprising, may be due to two factors. First, demand for eggs may have become more price elastic in the past several years due to heightened concern over cholesterol. Second, retail prices for eggs in California were over 40 percent higher on average than the national average over the sample period, and hence it is reasonable to expect a higher elasticity in California.

The positive and significant coefficient on the meat price index indicates red meats are substitute products for eggs. The positive coefficient on income suggests eggs are a normal good. Similar to other studies, both cross-price and income parameters show inelastic responses to price (0.20 and 0.07, respectively). Farm-level demand was higher in the fourth quarter which may be due in large part to the holiday season. Not surprisingly, given the steady decline in consumption since 1985, the trend variable displayed a negative and statistically significant relationship.

Lagged, as well as current, generic advertising expenditures are included to account for delays in the demand response to advertising (see, for example, Forker and Ward, p. 169). To mitigate the impact of multicollinearity among the lagged advertising variables, the lag weights were approximated using a second degree polynomial lag structure with both endpoints restricted to zero. In this way only one advertising parameter had to be estimated. Several lag lengths were considered for up to a full year (four quarters). Based on the significance of the lagged coefficients, three lags were included in the final specification. The estimated coefficients indicate that generic advertising had a positive and statistically significant (at the 10 percent significance level) impact on California farm-level demand and ultimately per capita egg consumption. The long run elasticity, obtained by summing the advertising elasticities over all lags, was 0.13, i.e., a 1 percent increase in advertising expenditures resulted in an average increase in producer egg price of 0.13 percent.

Producer Returns to Advertising

A dynamic, in-sample simulation was conducted to measure how well the model replicated historical values of the three endogenous variables: farm price, production, and consumption. Root Mean Square percentage errors (%RMSE)

were computed to measure how predicted values deviated from actual values. The %RMSEs for price and production were 2.1 percent and 0.5 percent, respectively. In addition, acceptable MSE decomposition proportions existed for all endogenous variables, with small proportions corresponding to the bias (U^m) and regression (U^r) components and proportions close to one corresponding to the disturbance component (U^d). Thus the model was deemed acceptable for simulation purposes.

While the econometric results indicated that generic egg advertising had a positive impact on price, the bottom line to California egg producers is the impact on net revenue. In order to ascertain the impact of advertising on producer revenue, the model was simulated under two alternative scenarios: (1) with actual, inflation-adjusted advertising expenditures, and (2) with a 1 percent increase in expenditures. The change in net economic benefits to producers was then computed for each quarter in the sample as the difference in producer surplus, i.e.:

$$(3) \qquad \Delta PS_t = \Delta GR_t - \Delta C_t ,$$

where ΔPS is the change in producer surplus for each time period t, ΔGR is the change in gross revenues, and ΔC is the change in production costs. The simulation procedure not only accounts for the production response due to changes in producer prices from advertising, but also accounts for the impact of checkoff assessments on producer costs.[8] This was accomplished by subtracting the per unit checkoff from producer prices generated through the simulation procedure, and therefore the simulated gross revenues are net of checkoff payments.[9]

The results of this simulation indicated that generic egg advertising had a substantial impact on egg producers' net revenue. A 1 percent change in real

[8]Since the generic advertising programs must also cover overhead costs, they should also be included in the return calculation; however data on these costs are not available. In addition, some assessment revenues are directed towards education, public relations, and research programs but due to data limitations, cannot be directly modeled here.

[9]See Reberte, Schmit, and Kaiser (1996) for a further explanation of this procedure. The model was simulated in SAS using the simulation procedure in PROC MODEL.

advertising expenditures resulted in a 0.13 percent increase in producer prices.[10] Furthermore, a 1 percent change in real advertising expenditures, which is equivalent to $304,000, resulted in a change in producer surplus of approximately $2.1 million over the entire sample period. This translates into a marginal rate of return 7.0 (i.e., an additional dollar added to existing advertising expenditure levels generated $7.00 in producer profits). As a means of comparison, Liu, et al. (1990) computed a marginal rate of return for the national dairy advertising campaign of 4.8 and Ward (1992) estimated a marginal rate of return for the beef checkoff program of 6.7. This result has two important implications. First, California egg producers are benefiting from generic egg advertising because the benefits exceed the cost of the program. Second, since the marginal benefits of advertising exceed its marginal costs, more money should be spent on advertising California eggs.

Finally, the Internal Rate of Return (IRR) to advertising expenditures was calculated. The IRR method is common in *ex post* evaluation of research projects and it allows ranking of alternative programs in terms of their relative profitability (Alston, Norton, and Pardey, 1995). The procedure is similar to the rate of return method previously discussed; however, here the returns to advertising are calculated by discounting the stream of benefits and costs over time. The IRR to generic advertising is the solution to:

$$(4) \qquad 0 = \sum_{t=0}^{n} \frac{\Delta PS_t - \Delta AE_t}{(1 + IRR)^t}$$

where AE denotes advertising expenditures. Based on the above equation, a monthly IRR of 59.3 percent was generated. A program is considered profitable if its IRR exceeds the opportunity cost of the funds invested.

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[10]Similar simulations were run at advertising changes of 10 percent and 50 percent; resulting in percentage increases in average producer prices of 1.2 percent and 5.3 percent, respectively.

Summary

A supply and demand econometric model of the California egg industry was estimated to evaluate the impact of generic egg advertising in the state on producer prices and returns over the past ten years. Econometric estimation indicated advertising efforts have had a positive impact on producer prices and net profits. The model was simulated with existing advertising expenditure levels, and with expenditures 1 percent higher than actual levels. A 1 percent change in advertising expenditures resulted in an average 0.13 percent increase in producer prices and a marginal rate of return to advertising of 7.0. In other words, each additional dollar spent on advertising generated $7.00 in producers' profits. The estimated returns to generic egg advertising in California indicate that advertising efforts in the state have been quite profitable.

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