Generic Advertising without Supply Control: Models and Public Policy Issues

Dermot J. Hayes and Helen H. Jensen

Working Paper 88-WP 39
December 1988

Contents

Figures

Tables

Abstract

Both producers and consumers may respond to the use of producer contributions to fund commodity promotion. The microeconomic foundation is laid for evaluating generic promotion campaigns where government is involved, supply is uncontrolled, and markets are close to saturation. The recent legislation enabling beef and pork promotion provides an application for the model.

Introduction

Do producer-funded generic promotion schemes increase producer welfare? The pork and beef producer groups promote their meat products to increase strength in the marketplace and hence to enhance producer welfare. With more than one producer group involved, this can happen only if the net impact of all these campaigns increases demand for animal proteins. American consumers, however, seem to have reached some biological and aesthetic limit on total caloric consumption. The government has used its legislative power to enforce compliance in these promotional programs. Can this intervention be justified even if one assumes that the government is interested only in producer welfare? If these promotions somehow do increase prices, will producers respond to these prices by increasing the quantity supplied, eliminating any return to advertising? This paper is an attempt to build a framework within which these questions can be answered, taking account of producer and consumer response, as well as competing products.

Marketing orders authorized by the Agricultural Marketing Agreement Act (AMAA), as well as the process for initiating separate legislation for other specific agricultural commodities, have enabled national funding of generic advertising since 1937. The U.S. Department of Agriculture (USDA) is responsible for conducting hearings on the need for free-standing legislation and supervising referendums. Promotion programs currently authorized under the separate federal statutes include wool, cotton, potatoes, eggs, and dairy (Manley and Kenney); national checkoffs were approved for beef and pork in 1988. The large sums of money involved (in 1985, more than $500 million [Frank]), as well as the involuntary nature of some of the programs

(e.g., beef, pork, wool, and dairy), have generated considerable producer and academic interest in evaluating the effectiveness of these promotions.

Promotions funded by producer contributions may increase the cost of the commodity through the additional cost of the checkoff and lead to a transfer from consumers to producers or to advertising agencies. For example, supply changes and their associated adjustment costs will occur in a competitive industry when promotion efforts are effective. This case is typical for agricultural commodities (Nerlove and Waugh). If the changes are temporary--such as those caused by advertising decay--there may be a need for continued promotion to maintain demand at new and higher levels. If demand cannot be maintained, the industry or public will bear the associated costs. This paper examines the microeconomic foundations for this research within the context of public policy and makes more explicit the methodological requirements for program evaluation. The analysis is applied specifically to an illustration of promotion within the livestock sector.

The paper is organized as follows. First, a review of past theoretical and empirical approaches to analyzing advertising and commodity promotion highlights the inconsistencies of previous models and empirical work on government-mandated advertising. Next, a framework is established for evaluating advertising and promotion programs. This includes a review of the demand and supply issues and an extension of the Nerlove and Waugh (N-W) theoretical model for evaluating the profitability of advertising and promotion. Derived measures of the effectiveness of promotion programs show the importance to evaluation of the responsiveness of supply to price, as well as the interactions among meats within a demand system. Finally, the implications are discussed in terms of decisions required by policymakers charged with oversight responsibility for commodity promotion.

Previous Work

Formal theoretical discussion of the effects on demand from advertising began with a paper by Kaldor. He discussed how firms could discover optimal advertising expenditures and the effects of these expenditures on equilibrium prices. Other researchers examined the influence of taste changes on both utility functions and indifference contours (Ichimura, Tintner) and the effect of advertising as a change in taste (Bassmann). Incorporating changes in taste into the utility-maximizing framework followed from Pollak's classic paper published in 1970, where he introduced the concepts of dynamic demand and utility functions. This literature is reviewed in Phlips (Chapter 7). Green extended the theory to show how the information made available by advertisements could change consumer preferences, and Kotowitz and Mathewson analyzed the relationship between consumer tastes and the availability of information about product characteristics. In addition to this work, the debate continues on whether advertising can change tastes (Dixit and Norman, Stigler and Becker).

Empirical evaluations of commodity promotion date to 1961, when Nerlove and Waugh published a market model evaluating advertising effects without supply control and applied this to a study of the promotional activities related to orange juice. This paper has become a classic. Subsequent empirical studies utilized controlled experimental design as well as market-based evidence. For example, in the early 1960s, a group of USDA researchers (Clement et al.) ran a controlled experiment to evaluate the generic promotion of fluid milk (Forker). The design was similar to that used by agronomists to test fertilizer response (i.e., similar market areas received different levels of advertising). They concluded that advertising did increase sales. In the mid-1960s, research at the University of Florida on the effectiveness of promotional campaigns for fresh citrus used econometric techniques to demonstrate

that the effect of citrus advertising carried over after a campaign was finished (Lee 1983). These techniques were applied to evaluation of the New York milk promotion program in the early 1970s. The research, based at Cornell University, has demonstrated a decreasing marginal return to advertising expenditure levels (Kinnucan), a complementarity between branded and nonbrand advertisements (Kinnucan and Fearon), and the importance of seasonality (Kinnucan and Forker). Recently, Liu and Forker have used a transfer function approach to examine returns to fluid milk advertisers in New York.

One noticeable difference between the theoretical and empirical approaches mentioned is that, although the theoretical papers provide a basis for incorporating and measuring own and cross-commodity advertising effects, the empirical models have, to date, used ad hoc single-equation analysis (an exception is Goddard and Amuah). There are two aspects of the single-equation approach that make it unsuitable for present purposes. First, by ignoring the cross-advertising effects, much of this research is useful only for the purposes of the individual industry in question. Second, ad hoc single-equation specifications for evaluating advertising effects on goods that have close substitutes make it difficult to choose the explanatory variables and the functional form for use in estimating the demand equation. Advertising effects, if they exist, will be relatively small. In this case, it may be possible to provide results that show either a positive or negative impact on the focus variable with the appropriate choice of explanatory variables (Leamer).

For the purposes of evaluating the public sector's role, the cross-advertising effects are as important as the own advertising effects. The emphasis on cross-price effects and the requirement that these effects be measured in a theoretically sound and robust way motivate the use of the demand system approaches developed in the theoretical literature and guide the model used in this paper. These methods allow

for the imposition of Slutsky symmetry and specify the functional relationships between commodities.

A Framework for Evaluation

Despite N-W's attention to the supply adjustments in a competitive industry, little of the research on commodity promotion takes account of supply adjustments (notable exceptions are that of Thompson and Eiler and of Lee 1981). However, for agricultural commodities facing well-ingrained habits in consumption, the demand response to advertisement is likely to be subtle. Although better understanding of changing demand structure is essential, analysis of market-level effects and producer behavior is required to evaluate the aggregate impacts of generic advertising.

The example of beef and pork promotion provides a useful way to consider the methodological issues related to evaluating promotion in a multicommodity context. Although the consumption levels for individual meats have varied substantially, the total quantity of meat consumed nationally has been remarkably stable; the presence of a slight upward trend may be due to increases in real income. Figure 1 shows how total meat and poultry consumption, as well as per capita meat expenditure deflated by the CPI, have varied through time. There seems to be an upper limit to the total amount of meat consumers are willing to purchase. This phenomenon has implications for the analytical framework.

In traditional demand analysis, meat expenditures are treated as weak-form, separable from other expenditures. This implies that, with overall meat expenditures remaining constant, any increase in expenditures for one meat can come only at the expense of other meats. Thus, any successful promotional campaign for one meat will have cross-commodity effects on the prices and quantity demanded of other meats. Should cross-commodity effects be large, they will influence prices and quantity

produced in other meat markets, which will influence the equilibrium of the original market.

Successful promotion programs may have offsetting effects on supply. If net prices to producers are eventually increased, producers will be free to respond to these prices with additional production, although short-run impacts may be negative as producers respond to anticipated higher prices in the future by building capacity (e.g., herd size). Increases in the marginal costs of production due to (per unit) producer assessment will dampen supply.

The Model

Nerlove and Waugh constructed a theoretical model for evaluating the static conditions for optimal advertising under competitive conditions (i.e., no supply control). The basic finding was that advertising is profitable if $(1 + e)a/(e - n)$ is greater than 0, where e is the elasticity of industry supply, n is the elasticity of demand with respect to price, and a is the marginal gross revenue from increased advertising expenditures, with prices held constant. In an extension and critique of the N-W results, Bockstael makes explicit a major shortcoming of applying the N-W results to promotion in agriculture. By assuming advertising to be financed by a single lump-sum assessment, N-W treats assessment as part of other fixed costs, which do not enter the marginal decisions of the firm. Alternatively, as Bockstael shows, assessments made on a per-unit-of-output basis (as is the case with most of the funding mechanisms for agricultural commodity promotion) affect the firm's marginal cost curve and hence the industry supply. The impact is to shift supply back, limiting supply on the market and enhancing the effectiveness of the program. The model outlined below is essentially an extension of Bockstael's critique to the case where

close substitutes exist and where legislation is used to ensure that funds are available. The model is applied to the meat industry, including beef, pork, and poultry.

The discussion of the model of the meat industry has two parts. In the first part, the conditions under which government and the individual producer group (industry) should support the promotions are derived. Profitability for an individual industry is shown to depend only on changes in the equilibrium quantity sold and on the slope of the marginal cost curve. This outcome has important implications for data needs and reflects the fact that prices are more volatile and less definable than quantity. From the perspective of the three industries considered together by the government, the government's evaluation of promotion effectiveness is shown to be determined by the impact of the promotion on the price of the product, related products, and the government's weighing of revenue to each of the industries. A rather surprising implication of this model is that none of the parameters of the demand system need to be estimated to evaluate whether or not advertising will be profitable for a particular industry. They are necessary when the impacts on the industries are considered together. Difficulty in evaluating the second-order conditions limits this application (and in the same way, the N-W model [Bockstael]) for evaluating the optimal level of advertising.

In the second part, the model is extended and applied to the evaluation of advertising and promotion effects on own and cross prices. Under specific assumptions on the nature of advertising and promotion effects, this model allows evaluation of the impact of any specified change in one meat price on the prices of related products.

The Basic Model

The following assumptions have been made:

1. There are three competing commodities (beef, pork, poultry).
2. The beef, pork, and poultry industries are perfectly competitive.
3. A measure of a successful promotional campaign is that producer profits, net of the advertising costs, increase.
4. The advertising budget is financed by a tax of $\$\tau$ per unit of production.
5. The market prices for beef, pork, and poultry can be described with a single statistic per market.
6. Industry costs can be represented as the sum of firm fixed costs (Z) plus the area under an aggregate marginal cost curve M(Q).

Following Bockstael's model for a single commodity, the multicommodity profit function is

$$\pi^i = P^i(Q^i, Q^j, A^i, A^j)\, Q^i(P^i, P^j, A^i, A^j) - \int_0^{Q^i} M^i(Q^i, \tau^i)dQ^i - Z^i \quad , \qquad (1)$$

where $i \neq j$, and

i, j represent beef, b; pork, p; and poultry, c;

π^i is profits of industry i;

τ^i is the per unit advertising tax in industry i;

A^i is total advertising expenditures of industry i, such that $A^i = Q^i\tau^i$;

P^i is market price of meat i;

Q^i is quantity of meat i sold or purchased;

$M^i(Q^i)$ is the inverse supply function of meat i; and

Z^i is the fixed production costs.

The first-order conditions for the optimal checkoff tax for meat i, from the perspective of the government, is

$$\lambda^i[P^iQ^i_{T_i} + Q^iP_{T_i} - M^iQ^i_{T_i} - \int_0^{Q^i} M^i_{T_i}dQ^i]$$

$$- \sum_{j=1}^{2} \lambda^j[P^jQ^j_{T_i} + Q^jP^j_{T_i} - M^jQ^j_{T_i}] = 0 , \qquad (2)$$

where $i \neq j$, subscripts denote partial derivatives, and λ^i is the weight placed by the federal government on profits earned by industry i.

The competitive market assumption allows us to write $P^i = M^i$. Also, note that the per unit checkoff implies that $\int_0^{Q^i} M^i_{T_i}\, dQ^i = \int_0^{Q^i} 1 dQ^i$.

Cancellation of like terms allows us to write the first-order conditions as

$$\lambda^i[P^i_{T_i} - 1] + \sum_{j=1}^{2} \lambda^j[(Q^j/Q^i)P^j_{T_i}] = 0 . \qquad (3)$$

Note that if $\lambda^i = 1$ and $\lambda^j = 0$, we obtain the first-order solution for an industry whose members produce only one meat. That is, $P^i_{T_i} = 1$.

However, the second derivative of the profit function with respect to advertising expenditures in this multigood case cannot be signed, as shown by Bockstael for the case of one good. Thus, equilibrium conditions can be used only to tell producers whether or not it pays to have advertising when the producer group starts from a position of no advertising. The "optimal" level of advertising thus becomes an empirical problem because the second-order conditions depend in part on estimating the impact of advertising on the responsiveness of demand to price and to advertising.

We can, however, define the conditions under which advertising is successful as

$$\lambda^iP^i_{T_i} > \lambda^i - \sum_{j=1}^{2} \lambda^j[(Q^j/Q^i)P^j_{T_i}] . \qquad (4)$$

The intuition behind this result can be seen by considering some possible values for λ^i and λ^j. If $\lambda^i = 1$ and $\lambda^j = 0$, the result indicates that an industry should advertise only if producers receive a net price increase; i.e., advertising would increase own

price by more than the checkoff tax. Note that, in this case, the evaluation is made only from the perspective of the single industry. If $\lambda^i = \lambda^j$ (i.e., $\lambda^b = \lambda^p = \lambda^c$), evaluating (4) under this condition implies that the government should support a beef checkoff, for example, if

$$P^b_{\tau b} > 1 - (Q^p/Q^b)P^p_{\tau b} - (Q^c/Q^b)P^c_{\tau b}. \qquad (5)$$

Then (5) implies that when beef advertising acts to reduce pork and poultry prices (i.e., $P^p_{\tau b}$, $P^c_{\tau b} < 0$), the conditions for advertising to be successful are that the net increase in the price of beef should be sufficient to offset the weighted losses in the pork and poultry industries.

If the impact of a beef promotion increases the prices of pork and poultry, the conditions under which the government should support a checkoff scheme are much less onerous. This would occur if the beef promotional campaign portrayed meat as a nutritious high-value product. Currently, the pork producers are running a campaign that encourages consumers to eat pork, "the other white meat." If effective, this campaign is likely to have a negative effect on beef prices and a positive or neutral effect on poultry prices. This is because the information contained in the pork campaign may reduce the marginal utility of beef. (These effects are discussed later.) Under these conditions, the requirements for effective pork advertising are more stringent (requiring a greater effect on price) from the public's perspective than from the perspective of the industry alone.

These conditions ignore the welfare of the consumer. Unless advertising increases consumer welfare by providing useful product-specific information, these promotions are a zero sum game. If all producers are to recoup the costs of promotions, they must eventually increase retail prices. An evaluation of the benefits to consumers would entail some valuation of the information provided by the campaigns; it would also include a measure of the benefit provided via increased media

revenues, which presumably increase media quality. These issues go beyond the scope of this study.

Evaluating Advertising Impacts

Additional information on the influence of the advertising tax on price can be obtained by a comparative static analysis of the market equilibrium conditions.

Let $Q^i = D^i(P^i, P^j, A^i, A^j)$,

$Q^i = S^i(P^i, \tau^i)$,

$A^i = \tau^i \cdot Q^i$.

Letting Q^0 equal the initial quantity of good i upon which the advertising tax is assessed, we can derive the equilibrium price and quantity changes:[1]

$$P^i_{\tau i} = \frac{D^i_A{}_i Q^0 - S^i_{\tau i} + \sum_{j=1}^{2} D^j_P{}_j \, P^j_A{}_i Q^0}{S^i_P{}_i - D^i_P{}_i}, \tag{6}$$

and

$$Q_{\tau} i = \frac{D^i_A{}_i Q^0 S^i_P{}_i - D^i_P{}_i S^i_{\tau i} + \sum_{j=1}^{2} D^j_P{}_j P^j_A{}_i Q^0 S^i_P{}_i}{S^i_P{}_i - D^i_P{}_i}. \tag{7}$$

Notice that the response of producers to a price increase $S^i_p{}_i$ should be the opposite of their response to a tax increase $S^i_{\tau i}$. If we substitute $S^i_p{}_i$ for $- S^i_{\tau i}$, it is possible to solve both (6) and (7) for the term

$$\frac{D^i_{A^i} Q^0 + \sum_{j=1}^{2} D^{P}_{p^j} P^j_{A^i} Q^0}{S^i_{P^i} - D^i_{P^i}} \quad . \tag{8}$$

This gives

$$P_{\tau^i} - \frac{S^i_{P^i}}{S^i_{P^i} - D^i_{P^i}} = \frac{Q_{\tau^i}}{S^i_{P^i}} - \frac{D^i_{P^i}}{S^i_{P^i} - D^i_{P^i}} \tag{9}$$

$$\Rightarrow P^i_{\tau i} - \frac{Q^i_{\tau i}}{S^i_{P^i}} = \frac{S^i_{P^i} - D^i_{P^i}}{S^i_{P^i} - D^i_{P^i}} = 1 \tag{10}$$

$$\Rightarrow P^i_{\tau i} = 1 + \frac{Q^i_{\tau i}}{S^i_{P^i}} \quad . \tag{11}$$

These are equilibrium conditions for industry i with competing products.

First, note that all cross-product effects have dropped out. Also, remember that for an individual industry to find advertising profitable, the sufficient condition was that $P^i_{\tau i} > 1$. Hence, producers themselves need only evaluate the signs of $Q^i_{\tau i}$ and $S^i_{P^i}$. The expression $Q^i_{\tau i}$ measures how the equilibrium quantity responds to advertising, and $S^i_{P^i}$ is the price responsiveness of supply. The equilibrium condition for the individual industry depends on the supply response within that industry. $S^i_{P^i}$ is expected to be > 0, although in the short run it may be negative. However, profitability of advertising depends on the sign of $Q^i_{\tau^i}$ as well. With $S^i_P > 0$, if $Q^i_{\tau i} < 0$, advertising is not profitable. That is, if an industry's price supply responsiveness is positive and if total quantity sold decreases with the campaign, then advertising is not profitable for that industry. If $S^i_P < 0$, then advertising would be profitable in the <u>short run</u> if $Q^i_{\tau^i} < 0$.

For the government to justify its intervention (and account for effects on more than one industry), the conditions are more severe. When revenues are equally weighted among industries, this requires that

$$P^{i}_{\tau i} > 1 - \sum_{j=1}^{2} (\lambda^{j}/\lambda^{i})\, P^{j}_{\tau i}(Q^{j}/Q^{i}) \quad . \tag{12}$$

Unless the cross-promotional effects on prices are positive, $P^{i}_{\tau i} > 1$ is a necessary but not sufficient justification for public support of the promotion.

One very intuitive implication of (11) is that generic advertising can never be profitable if it is carried on for a long period. This is true because S^{i}_{Pi} tends to infinity over time. Generic advertisement can at best provide a short-term boost to profits.

Own and Cross-Commodity Effects

The econometric estimation of the term $P^{j}_{\tau i}$ is made difficult by the number of components that must be measured. To see why this is so, consider the particular case of how advertising one meat affects the demand curves for other meats. Under the assumption that advertising provides information about product attributes, thereby changing the utility received from consuming that product, the short-run utility function may be specified as

$$U = f(Q, S) \ , \tag{13}$$

where S is a vector of state variables (i.e., the consumer's stock of information about the nutritional qualities of different foods). If we then hypothesize that advertising influences this stock of information, an equation of motion can be specified of the type

$$\dot{S}(t) = A(t) - \delta_i S(t) \quad , \tag{14}$$

where

A(t) represents the vector of advertising efforts made in time t, and

δ_i is the rate at which consumers forget the information contained within ads.

Maximization of this short-run utility function for any given stock of information, subject to the usual budget constraint, results in a set of Marshallian demand equations of the type

$$Q = Q(Y, P, S). \tag{15}$$

Total differentiation of these equations results in

$$dQ = Q_y dY + Q_P dP + Q_S dS \quad , \tag{16}$$

with

$$Q_S = -\frac{1}{\psi} KV \tag{17}$$

and

$$Q_P = K - Q_y Q' \quad , \tag{18}$$

where

ψ is the marginal utility of meat expenditures;

K is the substitution matrix;

Q_y is the vector of the expenditure terms;

V is the matrix of partial derivatives of the marginal utilities with respect to the state variables ($\partial^2 U/\partial Q^i \partial S^j$); and

Q_P is the matrix of Marshallian demand relationships.[2]

If V were known, one could solve (16) for dP/dS and, consequently, for P^j_{i}.

Where only changes in prices and quantities are known, as in the use of aggregate data, an accurate measure of V will be impossible. For example, this would involve the separating out from a livestock model how consumers' purchases of beef

respond to beef, pork, and poultry advertising, as well as the more traditional measures such as own and cross-price elasticities and supply responsiveness. The number of unknown relationships is greater than the number of observed variables.[3] In fact, it is not in the interests of any one producer group to measure $P^{j}_{\tau i}$. It may be, however, in the interest of the government to measure this term.

It is possible to use the general model (e.g., [15]) for three competing products, considering the special case for which a promotion campaign exists for one (beef) to illustrate cross-commodity effects. For this case, assume that the beef advertisements influence only the marginal utility of beef, and that in the short run (one quarter) meat and poultry supply and total expenditures are held fixed.

Holding expenditures and quantity fixed (dQ, dY = 0) by assumption, (16) becomes

$$Q_P dP + Q_S dS = 0 \; . \tag{19}$$

Substituting for Q_S from (17) and assuming the marginal utility of meat expenditures, ψ, is 1, (19) can be written in matrix form as

$$\begin{bmatrix} Q_{bb} & Q_{bp} & Q_{bc} \\ Q_{pb} & Q_{pp} & Q_{pc} \\ Q_{cb} & Q_{cp} & Q_{cc} \end{bmatrix} \begin{bmatrix} dP^b \\ dP^p \\ dP^c \end{bmatrix} = \begin{bmatrix} K_{bb} & K_{bp} & K_{bc} \\ K_{pb} & K_{pp} & K_{pc} \\ K_{cb} & K_{cp} & K_{cc} \end{bmatrix} \begin{bmatrix} V_{bb} & 0 & 0 & dS^b \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} \tag{20}$$

where

- c represents poultry;
- b represents beef;
- p represents pork; and
- Q_{ij} represents the change in demand for good i caused by a change in the price of good j.

Note:

$$V_{bb} = \frac{\partial^2 U}{\partial Q^b \partial S^b} \; . \tag{21}$$

Using the Slutsky relationship for (18) and performing the matrix multiplication just indicated produces, after some manipulation,

$$Q_{bp}dP^p + Q_{bc}dP^c = [K_{bb}V_{bb}]dS^b - [K_{bb} - Q^b\epsilon^b y]dP^b , \quad (22)$$

$$Q_{pb}dP^p + Q_{pp}dP^c = [K_{pb}V_{bb}]dS^b - [K_{pb} - Q^b\epsilon^p y]dP^b , \quad (23)$$

$$Q_{cb}dP^p + Q_{cc}dP^c = [K_{cb}V_{bb}]dS^b - [K_{cb} - Q^b\epsilon^c y]dP^b , \quad (24)$$

where $\epsilon^i y$ is the expenditure elasticity for a particular meat. One measure of V (i.e., $\partial^2 U/\partial Q^i \partial S^j$) would be the change in the consumer's willingness to purchase the same quantity of good i at a new price. This is true because in equilibrium the marginal utility of a particular item will equal its price. Any change in the marginal utility of an item will be reflected by the consumer's willingness to purchase more of that item at the same price, or to continue to purchase the same quantity at a different price. Assume the special case wherein only the marginal utility of beef is affected by beef advertising, and in which short-run meat supply and total expenditures are fixed; one corollary of these assumptions is that the advertising-induced change in beef prices will, in equilibrium, be equal to the advertising-induced change in the marginal utility of beef. This may be expressed as

$$dP^b = \frac{\partial^2 U}{\partial Q^b \partial S^b} dS^b , \quad (25)$$

where the first term on the right-hand side is the change in marginal utility of beef consumption of the average consumer for each incremental change in that consumer's information about the product.[4] If this relationship did not hold, utility-maximizing consumers would not purchase the total quantity of beef supplied.

Using relationship (25) for beef ($dP^b = V_{bb}dS^b$) yields

$$Q_{bp}dP^p + Q_{bc}dP^c = Q^b\epsilon^b{}_y dP^b \quad , \tag{26}$$

$$Q_{pb}dP^p + Q_{pp}dP^c = Q^b\epsilon^p{}_y dP^b \quad , \tag{27}$$

$$Q_{cb}dP^p + Q_{cc}dP^c = Q^b\epsilon^c{}_y dP^b \quad . \tag{28}$$

These relationships ([26], [27], and [28]) have an intuitive interpretation. Beef advertising has increased the marginal utility of beef. With fixed supply, this is reflected in an increase in beef price. However, this price increase for beef does not increase pork demand via the substitution effect (K_{ij}). This is true because consumers do not perceive a change in the quality-adjusted price of beef; hence, the change in beef price is absent from the left-hand side of (26), (27), and (28). Consumers do, however, spend more on beef equal to $Q^b dP^b$. Because meat expenditure is held constant, this expenditure shock must be compensated for by reduced expenditures on pork and poultry. Fixed supplies of pork and poultry imply that this is reflected in changes in the prices of the commodities. In other words, the prices of pork and poultry must adjust to compensate for the increase in beef prices so that the consumer can continue to consume the same bundle. This adjustment in pork and poultry prices is felt in proportion to their expenditure elasticities and their own price and cross-price elasticities, via (27) and (28).

For any specified change in beef prices, it is possible to estimate the resulting change in pork and poultry prices. This is achieved by specifying (27) and (28) in matrix notation and solving for dP_p and dP_c by using Cramer's Rule to get

$$dP^p = \frac{dP^b \cdot Q^b \cdot \epsilon^p{}_y \cdot Q_{cc} - dP^b \cdot Q^b \cdot \epsilon^c{}_y \cdot Q_{pc}}{Q_{pp} \cdot Q_{cc} - Q_{pc} \cdot Q_{cp}} \quad , \tag{29}$$

and $$dP^c = \frac{dP^b \cdot Q^b \cdot \epsilon^c{}_y \cdot Q_{pp} - dP^b \cdot Q^b \cdot \epsilon^p{}_y \cdot Q_{cp}}{Q_{pp} \cdot Q_{cc} - Q_{pc} \cdot Q_{cp}} . \qquad (30)$$

Hence, for any arbitrarily specified value for dP^b, the resulting change in P^p and P^c can be determined using known relationships. Under the restrictive assumptions of fixed quantity and expenditure, and of an advertising impact as specified above, dP^p and dP^c are measures of $P^j_{\tau i}$.

Example Applied to Beef

To assess the profitability of the generic promotion and advertising program, the relevant empirical questions are the impact of generic advertisement on the volume of sales (11), the impact of successful advertising in one market on the prices of close substitutes (4), and the sign of the price responsiveness of supply. A quarterly model of the U.S. livestock sector was used to provide model-based parameters that have been estimated econometrically (CARD), although for present purposes it is best to treat these variables as synthetic. The model-based parameters reported in Tables 1 and 2 were used in two illustrative examples.

Because consumption changes are likely to be subtle and evaluation of promotion programs may require several years of data from controlled market studies, simulations based on model-based parameter estimates were used as a means of better understanding responses in the livestock sector. Two illustrations show how the advertising campaigns can be evaluated. The first evaluates the campaign from the perspective of a single industry; the second demonstrates the importance of cross-price effects, especially with respect to public sector evaluation.

Illustration 1. The first example is an application of (11) to the case in which the objective function is that of a single industry. The case is that of a hypothetical beef industry campaign with a promotion program in effect for one quarter. This

particular simulated campaign has the effect of increasing the price consumers are willing to pay for beef by 4.5 percent, or approximately 12 cents per pound. To see how the evaluation might be done, compare (11) and (4). From (4) we know that advertising is successful if $P^i_{\tau i}$ is greater than one. Equation (11) shows that this will be the case if the ratio $Q^i_{\tau i}/S^i_{Pi}$ is positive.

Note first from Table 2, S^i_{Pi} for the short run (after one year) is small and negative. If we assume that the price responsiveness of supply remains unchanged by the campaign, we need only measure $Q^i_{\tau i}$ through the simulation. This may be defined as the advertising-induced changes in the quantity of meat sold. This effect appears as the induced quantity changes, illustrated in Figure 2. In the last quarter of the campaign (quarter four), beef supplies have decreased because of the promotion (i.e., $Q^i_{\tau i} < 0$). In this case, given the negative short-run supply elasticities, the campaign is deemed successful in the fourth quarter. The evaluation during the next year depends on the quarter chosen and the supply elasticity used. Clearly, evaluating a promotion campaign in the short run is sensitive to the period of observation and the short-run effects on supply.

By going to a longer-term analysis, evaluated at the end of five years, the impacts are more clear-cut: $S^i_{Pi} > 0$ and $Q^i_{\tau i} > 0$. From the perspective of a single industry, the promotion is successful five years after the start of the promotion effort. Although the requirements for immediate evaluation may be important to the industry, the illustration highlights the importance of the period for evaluation and, perhaps, of a longer-term perspective.

Illustration 2. An example based on certain assumptions about the nature of the beef advertising effect can be used to illustrate cross advertising effects and their importance relative to the impacts of promotion within the livestock industry. To see how this might be done, consider how a successful beef campaign might influence pork

and poultry prices. In the short run, the supply of beef is relatively fixed. An outward shift in the demand curve will be reflected in higher beef prices. For policy purposes, the unique aspects of meat advertising are the high degree of substitutability among meats and the relatively fixed nature of total meat consumption or expenditures. The simplified model described above can be used to evaluate the success of a campaign.

By using (29) and (30), the price effects dP^p and dP^c were evaluated as follows. By assumption, a beef campaign in the first quarter of the period increased beef prices by 12 cents for every 10 cents of assessment per pound; that is, $P^b_{\tau b} = 1.2$. Meat supplies do not adjust in this first quarter; consequently, the change in pork and poultry prices can be determined by (29) and (30). In the second quarter, meat supplies were allowed to adjust to the earlier changes; by assumption the effect of the first-quarter beef advertising carried over into remaining quarters with a 50 percent decay rate ($\delta = 0.5$ in [14]). Total expenditures were held constant in the first quarter.

By using the specified parameters, the change in pork and poultry prices resulting from a 12-cent price impact can be determined by using (29) and (30). These calculations were performed by using the short-run demand parameters presented in Table 1. The resulting first-quarter changes in the prices of pork and poultry were -6.4 cents and -2.3 cents, respectively. The base, or convergent, values for the period of the simulation were $2.59 per pound for beef, and $1.65 per pound and $.79 per pound for pork and poultry, respectively.

If it is assumed that this 12-cent price change was the result of a 10-cent per pound advertising tax, the success of the scheme can be determined from the government's perspective. The right-hand side of (5) becomes

$$1 - \frac{4129}{7079}(-6.4) - \frac{3520}{7079}(-2.3)$$

$$= 1 + 3.73 + 1.14$$

$$= 5.87,$$

where 7,079 is total U.S. beef production (000 tonnes), 4,129 is total pork production, and 3,520 is total chicken production in 1987. Notice that from the perspective of an individual industry, the 12-cent increase in price for a 10-cent investment ($P^{i}_{ri} = 1.2$) would have been viewed as a successful program. From the government's perspective, the net increase in producer welfare was only 6 cents (12 - 5.87 = 6.13) per 10-cent tax (assessment), when the three industries were weighted equally; P^{b}_{rb} was not greater than the term on the right side. Hence, from the perspective of the livestock sector as a whole, the promotion was not successful. The simulated effect of the beef campaign on prices of all these meats is shown in Figure 3. The same result would have occurred throughout the first year of the campaign. Again, however, this figure emphasizes the importance of the time period used when evaluating these programs. Selection of other, later time periods may yield different results.

Theoretically, one could measure any impact of beef promotions on the marginal utility of pork consumption. In reality, however, the standard errors for the required elasticities would be large enough to make these calculations meaningless. The sensitivity of results to the estimated parameters highlights the importance of obtaining econometrically robust estimates of these parameters.

Summary and Implications for Policymakers

This paper has developed a relatively straightforward model that can be used to evaluate commodity promotion programs where supply response exists (i.e., competitive

industries) and cross-commodity effects are incorporated. The analysis has focused on evaluating conditions where promotion is profitable for an individual producer group and for related industries. Whether or not a promotion is deemed successful depends on whether the individual industry or the market sector is considered. Furthermore, short-term impacts may be different from those evaluated with a longer-term perspective. Indeed, industries that face large adjustment costs should keep in mind that campaigns may induce short-run adjustment costs on the industry; in the very long run, these can never be profitable with supply adjustments. In an industry with relatively free entry and the ability to expand production over time, profitability may not be the best measure of "success." It can be affected by promotion only in the short run. Other measures such as market share, market stability, or the size of the industry are more appropriate for long-run consideration.

Several implications for commodity producers and policymakers can be summarized:

1. If checkoff-funded promotion schemes are to be worthwhile from the viewpoint of an individual industry, the net impact of the checkoff on the equilibrium quantity sold must be greater than the responsiveness of supply to price. These promotions cannot be a viable long-term option because the price responsiveness of supply becomes very large with sufficient time.
2. Checkoff payments are to be preferred over lump sum payments because of their more restrictive effects on output and, therefore, on price.
3. Government involvement is best directed toward promoting increased consumption of meat as a commodity rather than sponsoring promotions to increase consumption of one meat by disparaging the quality of others.
4. From the perspective of an individual industry, promotional campaigns can be evaluated by measuring their impact on the quantity of sales. However, from

the public sector's perspective, the cross-promotion effect of price in related industries is necessary for assessing the impact. There seems to be no satisfactory method by which economists can measure this change given the data that are currently available. If the government is to justify its continued involvement in these matters, it should encourage the advertising agencies to place the ads in a manner that allows cross- sectional comparisons of various advertising levels in different regions. This would allow economists to scientifically measure the impact of these campaigns on the equilibrium quantity sold.

Figure 1. TOTAL MEAT CONSUMPTION AND EXPENDITURES

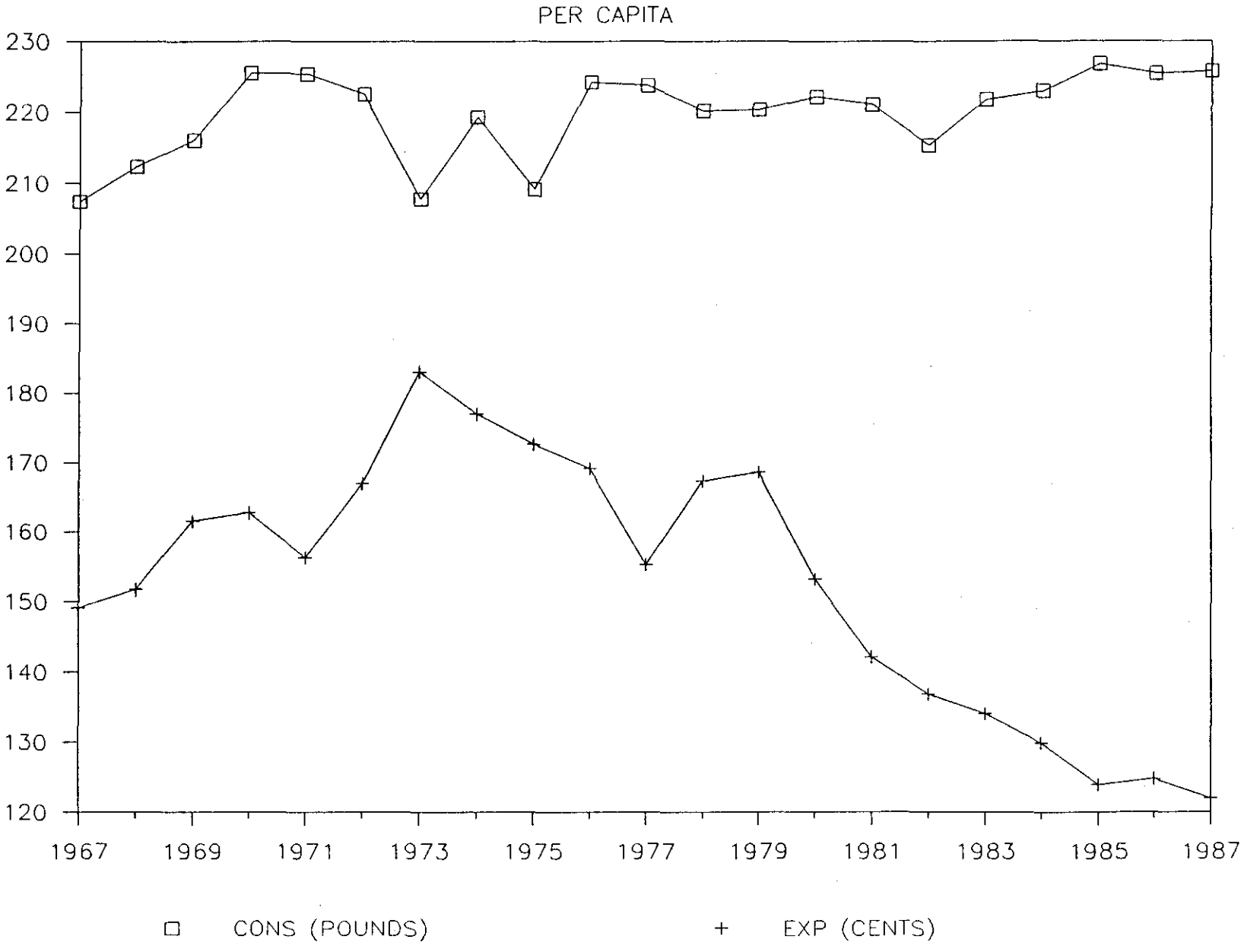

Figure 2. LIVESTOCK SUPPLY

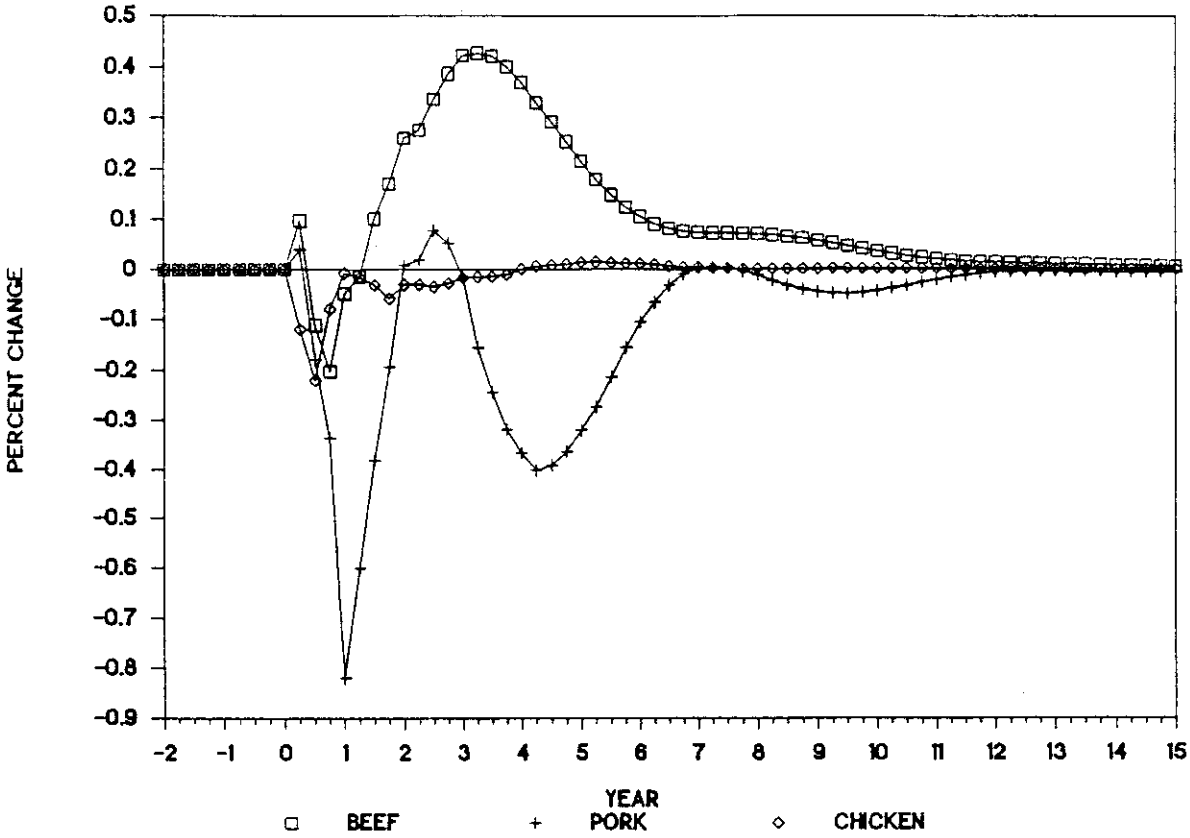

Figure 3. RETAIL PRICES

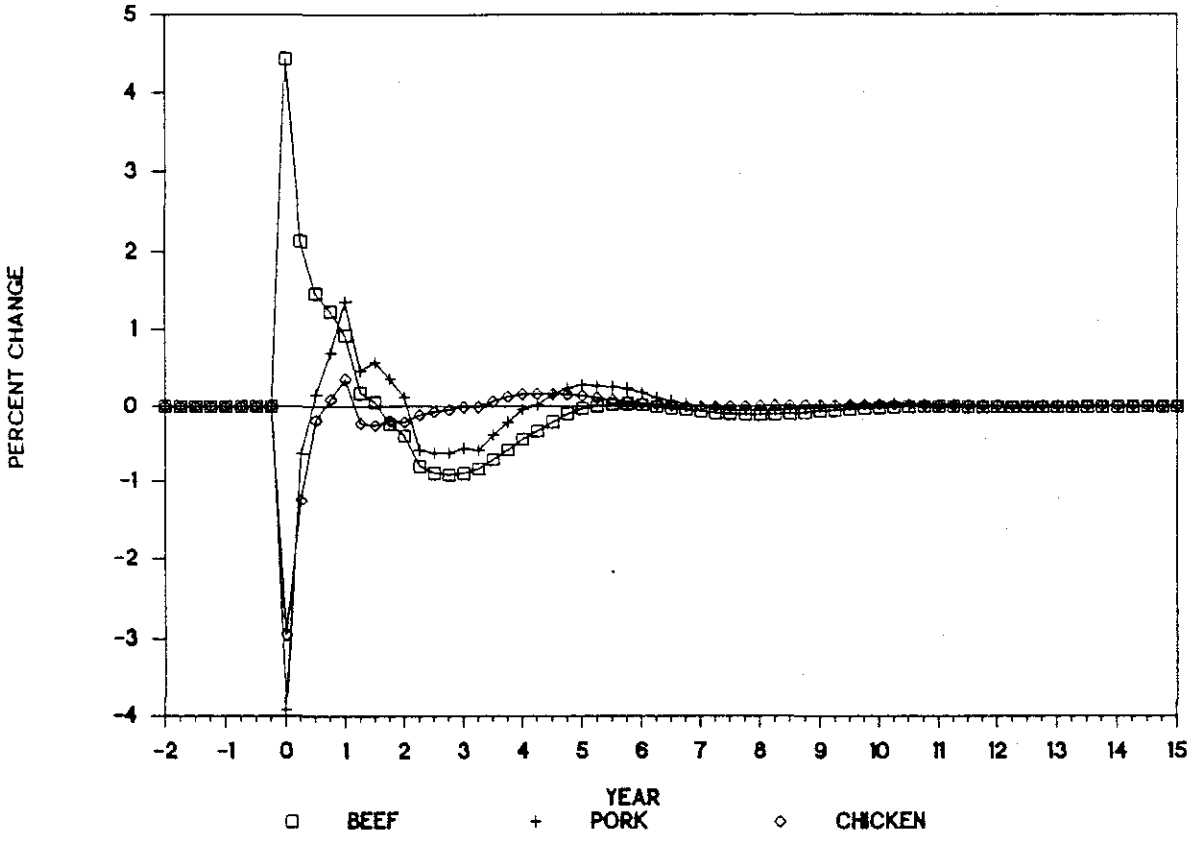

Table 1. Estimated elasticities for demand model with homogeneity and symmetry imposed in the long run and homogeneity imposed in the short run (estimation period 1967-86)

	Estimated Elasticities				Lag Adjustment Coefficient
	Beef	Pork	Chicken	Expenditure	
Beef					
Short run	-0.52 (0.08)[a]	0.23 (0.05)	-0.14 (0.05)	0.43 (0.20)	0.33
Long run	-0.80 (0.07)	0.30 (0.06)	-0.028 (0.02)	1.06 (0.30)	
Pork					
Short run	0.42 (0.06)	-0.70 (0.05)	-0.06 (0.04)	0.19 (0.17)	0.25
Long run	0.62[b]	-0.60 (0.07)	0.13 (0.07)	0.68 (0.23)	
Chicken					
Short run	0.06 (0.08)	0.19 (0.06)	-0.63 (0.06)	0.0004 (0.23)	0.17
Long run	-0.17[b]	0.34[b]	-1.05 (0.06)	1.24 (0.27)	

[a]The figures within the parentheses indicate standard error.

[b]Elasticity computed from the imposed symmetry restrictions.

Table 2. Constructed supply response elasticities for 1980-86

	Short-Run Elasticities	Long-Run Elasticities[a]
Beef Supply	-0.03	0.16
Pork Supply	0.02	0.50
Chicken Supply	0.10	b

[a]Elasticities represent approximate supply elasticities evaluated at 1984-86 mean values of exogenous variables and generated through dynamic simulation. The short-run elasticity is the change in total supply in the first year. The long-run elasticity was evaluated after each model converged to a new equilibrium.

[b]The chicken supply responded fully after one year (CARD).

Endnotes

1. If the campaign is ongoing, Q itself is endogenous, and therefore A is, too. This latter situation complicates the model slightly. Successive rounds of advertising expenditures result in an infinite series of adjustments that converge to $\Delta Q - D_A Q/(1 - D_A \tau)$. The intuition behind this term is that the total horizontal shift in demand ΔQ equals the initial shift D_A multiplied by the multiplier effect $1/(1 - D_A \tau)$. When Q is allowed to vary, the comparative static results are complicated to the extent that all terms containing a partial derivative of the demand curve are multiplied by the term $1/(1 - D_A \tau)$. Despite the inclusion of this term, the sufficient conditions for profitable advertising in the model remain unchanged (Bockstael). This is also true for the case with more than one commodity; hence, the term can be omitted because it complicates the algebra without changing the final results or conclusions.

2. These results are derived in Phlips, pp. 187-89.

3. The technology does exist that would allow these relationships to be measured; however, the data are very expensive and most often are purchased on a per item basis. Commercial companies have developed a technology, known as the split cable method, that allows for the measurement of the effect of single advertising campaigns. This is achieved by altering the television signal received by groups of individual households in a particular region and then closely monitoring the food purchases of these households to detect whether a particular campaign

actually influences household purchases. By exposing these households to only one type of promotion and monitoring their purchases of all meats, this cross-advertising effect could be measured. By assuming that the sample group of consumers were representative of the U.S. population, $P^{i}_{\tau j}$ could be calculated.

4. Strictly, the comparison of marginal utilities requires the further assumption of cardinal utility. The measure of change in marginal utilities is made under this and the restrictive assumptions that the state-induced changes influence only the marginal utility of beef.

References

Basmann, R. "A Theory of Demand with Variable Consumer Preferences." *Econometrica* 24(1956):17-58.

Bockstael, Nancy E. "Notes on Generic Advertising for Agricultural Products." Unpublished manuscript, Department of Agricultural and Resource Economics, University of Maryland, College Park, Maryland, September 1981.

Center for Agricultural and Rural Development (CARD). *CARD Livestock Model Documentation: Beef*. Draft Technical Report. September 1988.

Clement, W. E., Peter L. Henderson, and Cleveland P. Eley. "The Effect of Different Levels of Promotion Expenditure on Sales of Fluid Milk." Washington, D.C.: U.S. Department of Agriculture ERS-259, 1965.

Dixit, A., and V. Norman. "Advertising and Welfare." *The Bell Journal of Economics* 10(1978):1-17.

Forker, Olan D. "Chronology of Agricultural Economics Research Directed toward Evaluating Promotion Programs." Walter J. Armbruster and Lester H. Myers, eds. *Proceedings from Research on Effectiveness of Agricultural Commodity Promotion Seminar*. Arlington, Virginia, April 9-10, 1985.

Frank, Garry L. "Generic Agricultural Promotion and Advertising: An Overview." Walter J. Armbruster and Lester H. Myers, eds. *Proceedings from Research on Effectiveness of Agricultural Commodity Promotion Seminar*. Arlington, Virginia, April 9-10, 1985.

Goddard, E. W., and A. K. Amuah. "Advertising in the Canadian Fats and Oils Market." Department of Agricultural Economics and Business, University of Guelph, Ontario. Working Paper WP88/8, April 1988.

Green, H. A. J. *Consumer Theory*. 2d ed. New York: Macmillan, 1976.

Ichimura, S. "A Critical Note on the Definition of Related Goods." *Review of Economic Studies* 18(1950-51):179-83.

Kaldor, N. "The Economic Aspects of Advertising." *Review of Economics Studies* 18(1950):1-27.

Kinnucan, H. W. "Performance of Shiller Lag Estimators: Some Additional Evidence." Department of Agricultural Economics Research Staff Paper 81-8, Cornell University, Ithaca, New York, June 1981.

Kinnucan, Henry, and Deborah Fearon. "Econometric Measurement of the Sales Response to Generic and Brand Advertising of Cheese." Department of Agricultural Economics Staff Paper 84-21, Cornell University, Ithaca, New York, August 1984.

Kinnucan, H., and O. D. Forker. "Consumer Response to Milk Advertising." *American Journal of Agricultural Economics* 68(3):562-71.

Kotowitz, Y., and F. Mathewson. "Advertising, Consumer Information, and Product Quality." *The Bell Journal of Economics* 10(1979):566-88.

Leamer, Edward E. "Let's Take the Con Out of Econometrics." *American Economic Review* 73(1983).

Lee, Jonq-Ying. "Florida Department of Citrus Advertising Research Program." *Advertising and the Food System.* J. M. Conner and R. W. Ward, eds. North Central Regional Research Publication 287. Madison, Wisconsin: University of Wisconsin, September 1983.

Lee, Jonq-Ying. "Generic Advertising, FOB Price Promotion, and FOB Revenue: A Case Study of the Florida Grapefruit Juice Industry." *Southern Journal of Agricultural Economics* (Dec. 1981):69-78.

Liu, D., and O. Forker. "Generic Fluid Milk Advertising, Demand Expansion, and Supply Response: The Case of New York City." *American Journal of Agricultural Economics* 70(1988):229-36.

Manley, William T., and Mary C. Kenney. "Domestic Commodity Promotion Programs: Information Needs." Walter J. Armbruster and Lester H. Myers, eds. *Proceedings from Research on Effectiveness of Agricultural Commodity Promotion Seminar.* Arlington, Virginia, April 9-10, 1985.

Nerlove, Marc, and Frederick V. Waugh. "Advertising without Supply Control: Some Implications of a Study of the Advertising of Oranges." *Journal of Farm Economics* 43(1961):813-37.

Phlips, Louis. *Applied Consumption Analysis: Revised and Enlarged Edition.* Amsterdam: North-Holland Publishing, 1983.

Pollak, R. A. "Habit Formulation and Dynamic Demand Functions." *Journal of Political Economy* 78(1970):745-63.

Stigler, G. J., and G. S. Becker. "De Gustibus Non Est Disputandum." *American Economic Review* 67(1977):76-90.

Thompson, Stanley R., and Doyle A. Eiler. "Producer Returns from Increased Milk Advertising." *American Journal of Agricultural Economics* 57(1975):505-8.

Tinter, G. "Complementarity and Shifts in Demand." *Metroeconomica* 4(1952):1-4.