ECONOMIC ANALYSIS OF MEAT PROMOTION

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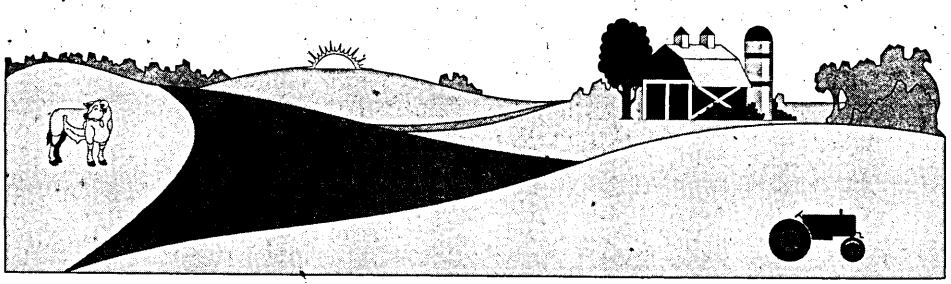

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Evaluating the U.S. Beef Checkoff: An Alternative Approach

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Generic advertising and promotion effectiveness remains an area of considerable economic controversy. One would not expect otherwise since generic advertising is usually funded through a direct mandatory tax on producers and/or handlers. Estimating the economic impact of specific programs has become an important component to the total evaluation of generic market enhancement activities. Evaluation efforts based on statistical inferences are usually limited by the available data one can compile about historical program activities. Such information may be aggregated across markets or consumers and then recorded over time. Or information may be across units measured at one point in time. Optimally, one would prefer to have such information recorded both across units and time. In all cases, the statistical methods must be adapted to the limits of the information available, recognizing that circumstances can render the problem not researchable in a quantitative sense (Forker and Ward, 1993).

In past evaluations of the U.S. beef checkoff programs, our initial statistical inquiries were based on time-series information aggregated across the U.S. markets. This continues to be an important avenue for evaluation of the beef programs and considerable economic inferences have been drawn from these models (Ward and Lambert, 1993; Ward, 1994). Given the importance and cost of the current U.S. beef programs, it is useful and informative to pursue additional ways to explore the economic impact of the beef programs. In this paper, our purpose is to offer another way to address the issue of measuring the economic impact of beef advertising and promotions. We will concentrate on the results without delving into the rigor of the methodology.

Suppose that instead of having information aggregated across consumers, detailed data exist about individuals including their purchasing behavior, demographics, and other relevant dimensions to the consumer. Each respondent may or may not be a consumer of beef. For beef consumers, research interest is with the intensity of consumption. The most pertinent questions relate to what influences the decision to consume and the intensity of consumption. If the database includes both consumers and nonconsumers, then three possibilities arise:

(a) All individuals are consumers of beef with the lowest level of consumption being zero. That is, consumption is truncated at zero.

(b) Zero consumption is an indication of not being a consumer of beef rather than being a consumer who has selected a zero level. For example, zero consumption could reflect the preferences of a vegetarian.

(c) Zero consumption could reflect both nonconsumers and consumers who have selected not to consume beef though they are beef eaters.

Alternative (a) is represented with the classic Tobit model where consumption is related to sets of explanatory variables with a constraint placed on the errors when the zero level is reached. Case (b) represents what is referred to as the Sample Selection model where the decision to participate or not is captured with the probability of entering the market. For beef consumers, the issue is one of estimating the appropriate relationships. Sample Selection procedures provide the methodology for estimating these models with the first part capturing the probability of becoming a consumer. Finally, Case (c) is often called a double hurdle model where one has to become a consumer and then decide to have a positive level of consumption. Given the nature of the data to be used and the wide distribution of beef throughout the U.S., subsequent analysis will concentrate on the sample selection model without comparing the results with the other cases. Preliminary analysis points to the appropriateness of the sample selection model (Blaylock and Blisard, 1992; Greene, 1990; Haines, Guilkey, and Popkin, 1988; Heckman, 1979; Jones, 1989; and Maddala, 1986).

Consumer Panel Database

As part of our general evaluation of the beef checkoff, household diary data were purchased from The NPD Group, a private data vender (The NPD Group, 1993). The NPD database includes households reporting the number of servings of beef included in a period of two weeks. The primary meal preparer reports these numbers along with demographics and related statistics about the household. These serving numbers are divided by the number of members in the household, thus giving a measure of beef use expressed in servings per household member. Hence, the number of servings represents a continuous variable having a minimum of zero and no measurable maximum. Clearly, a maximum exists but it is not reflected in the data set and thus does not place any upper bound to the analysis. Each household does not report on a continuous basis over time. Rather, the cross sectional identity may change with each reporting period. The full database includes monthly information covering the period from 1984 through 1993. These months, along with the reporting households, give a total of 17,109 observations.

Each primary food preparer provides data on several categories of information that can have a direct impact on consumption decisions. Respondents are asked questions in which they must provide an ordinal scale response. For example, the household primary meal preparer may be asked if he or she "*knows more about nutrition than most.*" A six-point scale response is then used where the respondent *"completely agrees," "mostly agrees," "somewhat agrees," "neither agrees or disagrees," " somewhat disagrees,"* or "*mostly disagrees.*" For some questions the term encourage or discourage is substituted for agree and disagree. Those questions requiring a scaled answer can be generally grouped into three categories: (a) behavior, (b) attitudes, and (c) knowledge. While discussing the full database is beyond the scope of this paper, an example of each category is helpful. One behavioral practice addressed the eating of fast foods such as pizza, lunch meat, french fries, and tacos. An attitude indicator includes the degree of concern you have about fats and cholesterol. One indicator of knowledge is addressed with questions relating to what you know about nutrition. These categories, along with the household demographics, provide a rich database for exploring the forces influencing the inclusion of beef in the diet.

NPD Group's panel servings diary does not include prices and advertising exposure. The exact month in which the servings took place is known. Given that the reporting months are known, retail beef prices have been incorporated into the panel database where it is explicitly assumed that everyone in the same period faces the same retail beef price. This is a reasonable assumption given the long period used and the high correlation seen in cattle prices throughout the U.S. (Ward, 1994).

Furthermore, it is the only alternative way to include prices in the model. Substitute prices are included in the same way.

Beef checkoff expenditures are included in a similar way as outlined for prices. Given the national exposure to beef advertising and the generally common copy across the program areas, it is reasonable to assume that every household had equal exposure to the beef promotions. Thus, total quarterly expenditures have been added to the household data for the corresponding months.

With the inclusion of prices and beef checkoff expenditures along with the demographics, behavioral practices, knowledge, and attitudes, adequate data exist for exploring the issue of what impacts the household decision to consume beef.

Sample Selection Model

Define X_1 and X_2 as two matrices of exogenous variables with the variables drawn from those identified above. Household consumption of beef is defined as Y_1 when the servings in a period of two weeks exceed zero. Further, define Y_2 as a zero/one variable reflecting if the household included beef in the servings over the two-week reporting period. Using these definitions, the basic model is defined below with the addition of the subscripts to identify the household (i) and time period (t).

$$Y_{1(it)} = X_{1(it)}\beta + \varepsilon_{(it)}, \quad \text{if } Y_{1(it)}>0 \qquad \text{(regression equation)} \tag{1}$$
$$= 0 \text{ otherwise}$$

$$Y_{2(it)} = X_{2(it)}\Gamma + \upsilon_{(it)} \qquad \text{(probit equation)} \tag{2}$$

As indicated above, we will not deal with the statistical properties of these relationships in this discussion but rather give an intuitive insight into the use of the estimated modeling technique. Equation (2) provides the probability of becoming a consumer. Once a consumer, then equation (1) establishes the relationship between serving intensity and those variables influencing these consumption levels. In these equations the residuals can be correlated and there can be overlap among the variables included in X_1 and X_2. As implied with these equations, the decision to become a consumer can be influenced by a different set of variables than those impacting the intensity of consumption. This flexibility is an essential difference between the Sample Selection model and the classical Tobit estimates.

For convenience, with results to be shown later, let $X_{(it)}=X_{1(it)}=X_{2(it)}$. This simply implies that the same sets of variables impact both decisions to consume and the intensity of consumption with the impacts differing by the vectors β and Γ. Furthermore, $X_{(it)}$ is partitioned into several types of variables corresponding to those described earlier letting $X_{(it)} = [H_{1(it)}, H_{2(it)}, P_{(t)}, G_{(t)}]$. Household demographic variables are included in $H_{1(it)}$. Household behavior and attitudes are captured with $H_{2(it)}$ while the appropriate price variables are included in $P_{(t)}$. See Kinnucan and Clary (1995) and Nayga (1995) for recent works on consumer characteristics and commodity modeling. Finally, the impact of beef advertising and promotion through the beef checkoff is expressed with the vector $G_{(t)}$. Note that both P and G carry only the time subscript since these variable values are not unique to each household unit. Our primary interest for this discussion is with the components P and G and their impact on beef servings. Table 1 includes a general description of the variables included in X. While the complete model provides considerable insight into the demand for beef, we will concentrate our discussion on the role of prices and the beef checkoff.

Table 1. Independent variables included in the beef sample selection model

H_1 Matrix - Behavior and Attitudes (six point scale)		
(1)	PC1 and PC2 =	Components in a health index
(2)	BH1, BH2 and BH3 =	Food eating behavior and practices
(3)	ATDOC =	Importance of doctor information about nutrition
(4)	ATREG =	Importance of eating regular meals
(5)	ATCAL =	Concern about calories
(6)	NTKNO =	Level of nutrition knowledge
(7)	NTPLN =	Importance of planning nutritious meals
(8)	NTLOK =	Importance of how food tastes and looks
H_2 Matrix - Demographics		
(1)	DMMSZ =	Market size where household member reside
(2)	DMMIN =	Household income
(3)	DMHSZ =	Number of members in the household
(4)	DMEDU =	Education of female head of household
(5)	TDMFEM2 =	Female head is employed
(6)	DTFEM =	Female head is on diet
(7)	CK2 & CK3 =	Time shifts for the period 1984/86, 1987/90, and 1991/93
P Matrix - Prices		
(1)	PPBF =	Quarterly average retail price of beef per pound ($)
(2)	PPPL =	Quarterly average retail price of poultry per pound ($)
(3)	PPPK =	Quarterly average retail price of fresh pork per pound ($)
G Matrix - Beef Advertising and Promotion		
(1)	SQRTADV =	Square root of the beef checkoff program expenditures ($ per capita)

A Graphical Approach to The Servings Model

Theoretically, preferences are established and consumption decisions made given the information a consumer faces. Consumers acquire much of their product information through advertising and promotion exposure. If the information is useful, consumers may respond with changes in their consumption of the product advertised. First, the response to any advertising and/or promotion message is contingent upon the attributes of the product being promoted. Second, the impact is conditioned by the quality and intensity of the message. For any promotion effort, the initial level of consumption is conditioned on the characteristics and household environment of the primary meal preparer. Using Figure 1, the response to the advertising and promotion intensity is illustrated for a given product, set of consumer characteristics, and a fixed message.

Figure 1 includes three axises with the servings per member in each household shown on the vertical axis. Beef checkoff expenditures are on the bottom right axis and retail beef prices are on the bottom left axis. First, holding the beef price fixed at P0, then without any checkoff efforts the number of servings per household member is S0. All other factors captured with H_1 and H_2 remain fixed. Assuming that the beef programs are effective, then the servings increase to S1 with increases in the beef checkoff expenditures. Note the curvature of this response function reflects the premise that the marginal gains from advertising and promotion decline with increased expenditures. While several models can be specified to depict this response, the square root of generic expenditures noted in Table 1 is an easily used form. The appropriate functional form is something that can be readily explored.

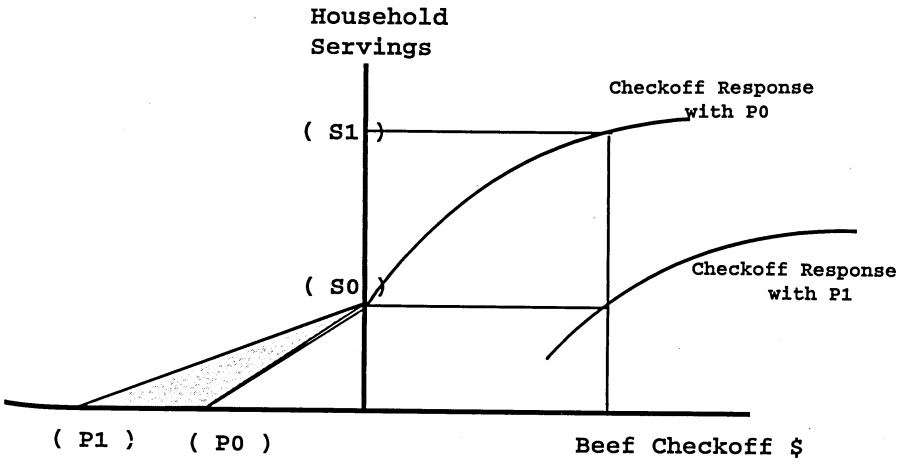
Since the servings are in units per two weeks and not in volumes, it is impossible with the current database to derive the explicit economic value resulting from the added expenditures. However, one simple option is to ask what is the implicit value of the advertising and promotion. That is, how much of a price increase would be required to move the servings back to the level before the advertising took place? In Figure 1, a rise in the retail price along the bottom left axis causes a downward shift in the servings for a fixed advertising effort. If both the advertising and price responses are known, then the relationship between advertising and the implicit price increase necessary to offset the gains can be derived.

For illustration purposes, let $y_{1(it)} = \alpha_0 + \gamma_1 p_{1(it)} + \gamma_2 \sqrt{g}$ where g is the checkoff expenditures and p_1 represents the retail beef price. All other factors are captured in α_0. Using this function, the linkage between price and advertising is evident.

$$dy_1 = \gamma_1 \, dp_1 + \frac{\gamma_2}{2\sqrt{g}} \, dg \qquad (3)$$

In Figure 1 and equation (3), implicit value of the advertising and promotion can be shown after setting dy_1 to zero and derive dp_1 for the advertising change from say g_1 to g_2. The implied price change associated with an increase in generic promotions depends on the assumed value for dy_1. Given estimates for γ's, then one can easily explore these relationships and draw several inferences relating to the effectiveness of the beef checkoff.

Figure 1. Beef servings and the theoretical impact of the beef checkoff



Sample Selection Model Estimates

Since the scope of this discussion is limited to those concepts illustrated in Figure 1, only those parameters relevant to this figure are presented. Recall that the Sample Selection model includes both the probit and regression equations. In Table 2 the corresponding coefficient estimates are reported for the retail beef price and the beef checkoff expenditures. Servings per household member are shown to be influenced by both the retail prices of beef and the beef checkoff programs. Note that the price effect is statistically significant for both the probit and consumption equations and carries the expected negative sign. The probit price coefficient is used to show the change in probability of becoming a consumer as prices are adjusted. Similarly, Column 4 shows that for every 10-cent price increase, one can expect the number of per capita servings of beef to decline by approximately .099 servings. This price effect is statistically significant at the 99% level. The coefficient value of -.0099 corresponds to the γ_1 depicted in equation (3) and thus represents the downward shift in the checkoff response curve that would result with an increase in the retail beef price.

The bottom row in Table 2 provides a measure of the impact of the beef checkoff on household beef servings. Beef checkoff expenditures are shown to increase the probability of becoming a consumer as measured with the probit coefficient .28469. Similarly, the beef checkoff has a positive and statistically significant impact on the number of servings included in a two-week

Table 2. Estimates for the retail and beef checkoff effects using the Sample Selection Model

Selected[a] Variables	Probit Equation		Consumption Equation	
(Col 1.)	Estimates (Col. 2)	t-Test (Col. 3)	Estimates (Col. 4)	t-Test (Col. 5)
Retail Beef Price	- .00268	(- 2.54626)	- .00990	(- 2.54332)
Square Root Beef Checkoff $	.28469	(2.49904)	1.04263	(2.47836)

[a] Write the authors for the full empirical estimates for the Sample Selection Model.

period. Referencing equation (3) again, the checkoff value of 1.04263 corresponds to γ_2 and is significant at the 99% confidence level. One cannot generalize about the checkoff impact as was done with prices since the marginal checkoff impact depends on how much advertising and promotion are going on. This is seen with the total derivative in equation (3) where the generic impact depends on the level of g along with γ_2. Obviously, if γ_2 in Table 2 were zero, then the checkoff response curve shown in Figure 1 would be completely flat and the servings would remain unchanged at all advertising and promotion levels.

Before turning to more definitive uses of the model, Table 2 establishes that with this alternative way of modeling the beef programs, the evidence is clear that a measurable effect of the advertising on beef demand exists. This effect is in terms of both influencing potential users of beef and to increase the servings among existing consumers.

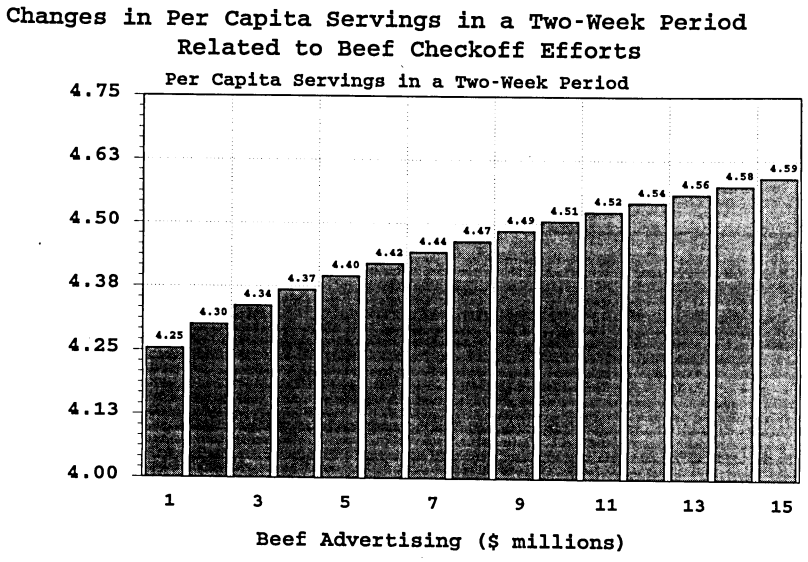
Simulating the Beef Checkoff Response

Applications of the Sample Selection model provide considerable insight into consumer responses to the beef checkoff efforts. While one can show the response over a range of demographic and other conditions, a useful approach is to calculate the number of servings across advertising and promotion levels while holding all other variables fixed. In all cases, with this model the assumed levels for other variables will either raise or lower the servings level but will not change the response to beef advertising. Relaxing this part of the model is currently being pursued.

Figure 2 illustrates the estimated checkoff response initially suggested with Figure 1. In this example, retail beef and other prices are set to their mean values for the years since 1991. With the other variables fixed, an initial beef checkoff expenditure of $1 million for the quarter points to an average of 4.25 servings per household member. For the upper case of $15 million for the same period, beef consumption increases to 4.59 servings per member. Increases for each incremental change in promotions are shown and the declining marginal response is most evident. For example, an increase from $1 to $2 million increases per capita servings by .05 units. In contrast, an increase from $14 to $15 million generates a .01 unit increase in servings.

Figure 2 has three important policy implications that deserve highlighting. First, the responses clearly show the range of meaningful gains that can be expected with beef advertising

Figure 2. Simulated servings response to beef checkoff advertising and promotion expenditures



programs. Knowledge of these increments is essential to having some expectation of what could be generated from additional programs and/or expanded efforts. Second, the upper limits to expected gains are apparent and thus Figure 2 provides some insight for setting optimal expenditure policies. Third, Figure 2 can be simulated for any number of demographic profiles and other conditions. One can compare the response curve values across education levels for example and then determine how much advertising and promotions would be required to bring one demographic profile in line with another. Also, some demographic and attitudinal profiles will yield lower servings than others. In turn, that suggests potential areas where program efforts may need to be directed. In general then, when simulated across the full set of variables initially identified in Table 1, Figure 2 provides useful insight into audience targeting. We again emphasize that the scope of this discussion has been limited, therefore we are not specifically detailing this last important dimension to using the model.

Implicit Value of the Beef Programs

Recent evaluations of the beef programs using quarterly aggregated market data consistently pointed to substantial returns to the beef checkoff. In fact, the most recent study by Ward points to a rate-of-return to each checkoff dollar to be around five. That is, on average each dollar of beef

checkoff expenditures results in five dollars of returns at the live weight market level. A limitation of the current analysis in calculating a similar rate-of-return exists because the servings are not in volume units of beef. Hence, one cannot precisely convert the servings into equivalent pounds of beef. Given this limitation, the procedure offered with equation (3) and Figure 1 provides one alternative to gain some insight into the economic value of the checkoff using these servings data.

From equation (3) changes in servings is set to zero (i.e., $dy_1 = 0$), then $dp_1 = -\{ \gamma_2 / (2\gamma_1 \sqrt{g}) \} dg$. This derivation simply shows the necessary price change that would be required to offset the gains from an increase in the checkoff expenditures. Given the estimates from Table 2 and adjusting for population (recall that advertising is on a per capita basis), then these price changes are easily derived. Furthermore, a linkage between retail and boxed beef prices can be approximated with a weight of .438 and boxed beef to live weight with the adjustment coefficient of .634. These weights are based on the average percent of each market price relative to the next level. Then a change at the retail can be approximated for the lives weight market level. This level is important since it is the producers who are funding the beef checkoff.

In Figure 3 price changes associated with increases in the beef checkoff are shown with the price adjustments calculated at the retail, boxed beef, and liveweight market levels. Each price change is calculated with the new advertising level relative to an initial expenditure of $1.5 million. For example, with an increase from $1.5 to $6 million, the retail beef price could increase by 25.4 cents to keep the servings level constant. With expenditures up to $12 million, the retail price change increases to 46.4 cents. That is, retail beef prices could increase by 46.4 cents before beef servings dropped below the servings at the initial advertising level. Clearly, the implicit value of the programs in terms of equivalent price changes is substantial. Using the weights for boxed beef and live weight noted above, the wholesale and live weight prices are calculated to be 20.3 cents and 12.9 cents, respectively, for the $12 million expenditure level.

All calculations in Figure 3 are based on $dy_1 = 0$ and the percentage price linkages between market levels. The empirical evidence points to a substantial implicit value to the generic advertising and promotion. Changes in dy_1 and the price linkage assumptions obviously influence the conclusions suggested with Figure 3 in terms of the amount of price change occurring.

Probit Impact on Consumers

In Table 2 we reported the coefficients for the Probit estimates along with the regression model. While Figures 2 and 3 illustrated the change in servings among consumers of beef, the probit coefficients provide insight into attracting households to include beef in their two-week serving period. The basic issue is to determine how prices and beef checkoff efforts change the probability of beef consumption. As with the prior discussion, the results are emphasized without detailing the analytical procedures.

Using Figure 4 we have calculated the probability of beef consumption based on the 17,109 households used in the Sample Selection model. Beef checkoff expenditures are plotted on the bottom axis and the probability of consumption is on the vertical axis. Three response curves are plotted, one for each of three levels of retail beef prices (i.e., retail price = $2.00, $2.50 and $3.00). As expected, the probability drops with higher beef prices. First, considering the zero beef checkoff level, the probability of becoming a beef consumer increases from near 75% to around 83% when retail prices are dropped from $3.00 per pound to $2.00. While retail beef prices seldom if ever drop that much, this range in probabilities provides a good perspective on the impact of price changes.

Figure 3. Simulated price changes associated with increased generic advertising expenditures

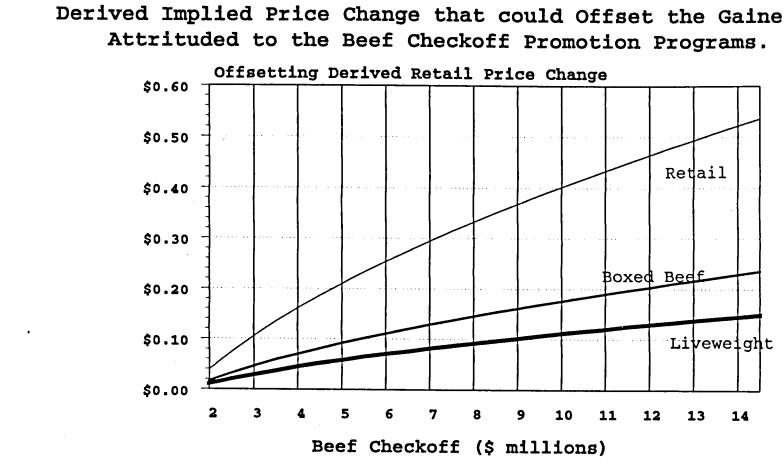
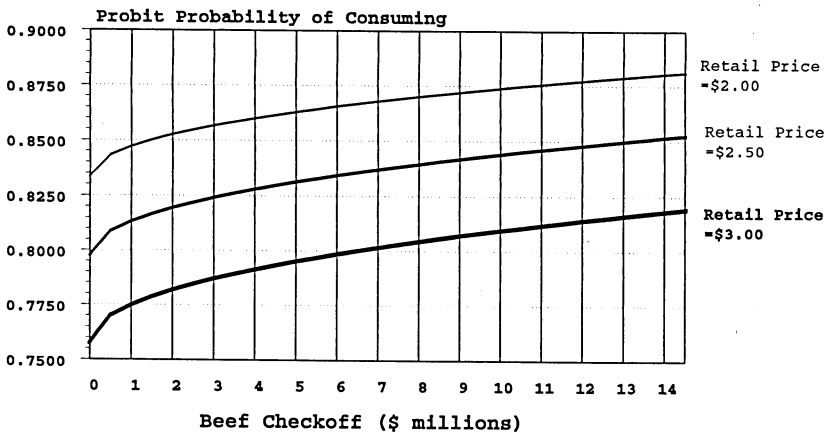


Figure 4. Estimated probabilities of becoming a consumer of beef based on the probit estimates from the sample selection model



In contrast with the price changes, each response curve in Figure 4 reflects the probability with increases in the beef checkoff programs. For example, at the $2.50 retail price the probability of consumption increases from around 80% to slightly over 85% when the checkoff expenditures are ranged from 0 to $14.5 million. This range is consistent with historical expenditure levels. Hence, Figure 4 provides a reasonable picture of what can be expected when attempting to attract new consumers into the market. Obviously, the percentage gains drop off with additional expenditures because of the declining marginal effectiveness of the checkoff efforts.

Figure 4 can be used to explore many market entry questions, especially when comparing demographic and attitudinal differences. The probabilities shift up and down depending on the values of the H_1 and H_2 variables noted in Table 1. To illustrate one example, suppose the beef checkoff was initially set to $3 million and the retail price was $2.50 per pound. If the retail price increased to $3.00 in Figure 4, it would be nearly impossible (or at least impractical) to advertise enough to bring the probability back to the level when prices were $2.50.

Conclusions

In this discussion we have concentrated on new model results without presenting the more technical aspects of the modeling effort. Using limited dependent variable procedures, the empirical evidence provides significant support that the U.S. beef checkoff is having an impact on the domestic demand for beef. Our analysis shows that the beef checkoff can both attract consumers to the market and increase the intensity of use of beef among existing beef eaters. Such results provide independent evidence supporting prior estimates of the economic impact of the beef checkoff. The implicit economic value of the beef checkoff was shown to be substantial. However, the nature of the consumption variable measured in servings per household member prevented a direct calculation of a rate-of-return to the programs. Research into a richer use of these data is currently underway.

Footnote

1. Ronald W. Ward is a professor in the Food and Resource Economics Department, University of Florida, Gainesville, Florida. Wanki Moon is a Ph.D. candidate in the same department. This research is supported by the Cattlemen's Beef Board, the National Livestock and Meat Board, and the National Cattlemen's Association.

References

Blaylock, James R., and W. Noel Blisard. "U.S. Cigarette Consumption: The Case of Low-Income Women." *American Jr. of Agri. Economics* 72(1992):698-705.

Forker, Olan, and Ronald Ward. Commodity Advertising: The Economics and Measurement of Generic Programs. Lexington Books. New York, NY. 1993.

Greene, William H. Econometric Analysis. Macmillian Publishing Company. New York, NY. p.715-753, 1990.

Haines, Pamela, David Guilkey, and Barry Popkin. "Modeling Food Consumption Decisions as a Two Step Process." *American Jr. of Agri. Economics* 70(1988):543-552.

Heckman, James J. "Sample Selection Bias as a Specification Error." *Econometrica* 52(1974):153-162.

Jones, Andrew M. "A Double-Hurdle Model of Cigarette Consumption." *Journal of Applied Economics* (1989):23-39.

Kinnucan, Henry, and Cynda Clary. "Brand versus Generic Advertising: A Conceptual Framework with an Application to Cheese." *Agribusiness* 11(1995):355-369.

Maddala, G.W. Limited Dependent and Qualitative Variables in Econometrics. Cambridge University Press. Cambridge, U.K. p. 221-252, 1986.

Nayga, Rodolfo M. "Consumer Characteristics Associated with the Selection of Pork Products." *Jr. of Food Product Marketing* 2(1995):17-30.

NPD. The NPD Group Net Data. Rosemont, IL. 1984-1993.

Ward, Ronald W. "Economic Returns from the Beef Checkoff." UF#NCA94.1. Gainesville, FL. Jan. 1994.

Ward, Ronald W., and Chuck Lambert. "Generic Promotion of Beef: Measuring the Impact of the Beef Checkoff." *Journal of Agriculture Economics* 44:3(1993):456-466.