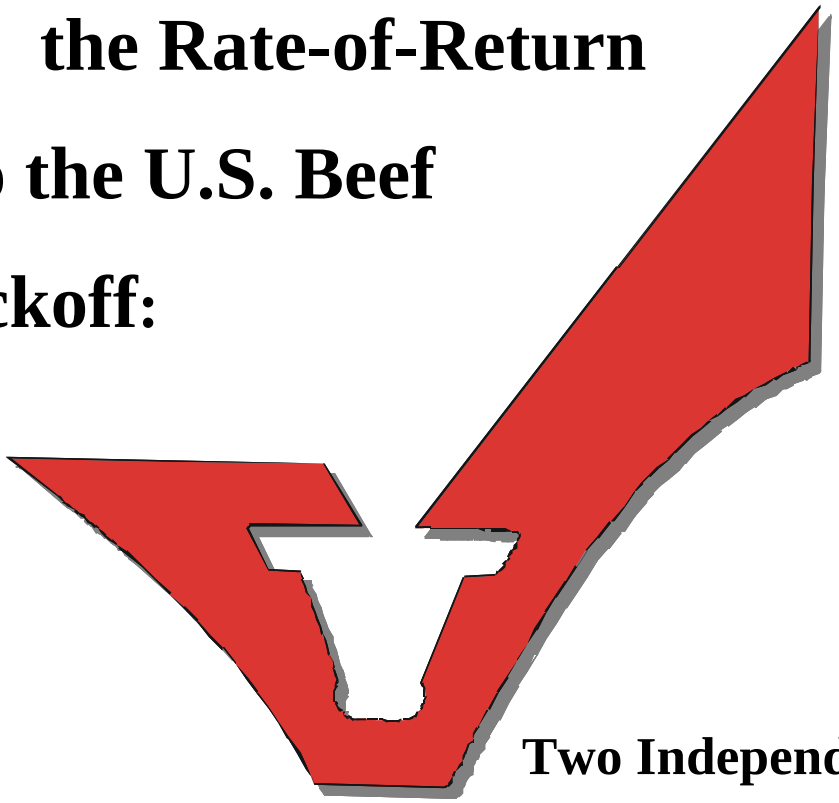
Beef Demand and the Rate-of-Return to the U.S. Beef Checkoff:



Two Independent Evaluation Approaches

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Preface

This research is part of an ongoing evaluation of the beef checkoff program funded by the Cattlemen's Beef Promotion and Research Board. Essential to the board's efficient use of the checkoff funds collected through an assessment on all cattle producers and importers is to know where the programs have been successful. Success has several dimensions with many being difficult to quantify. This study first and foremost is designed to determine empirically if there is a measurable link between beef demand and the generic promotion of beef. If it exists, then are the benefits worth the costs? At the outset it is extremely important to recognize that a quantitative approach alone is not the sole answer to determining the success or failure of a generic promotion program. One needs to review the underlying administrative structure, the creativity of the messages and their delivery, innovations in product development and communication strategies, and equity issues in terms of the distribution of benefits. Any measured impact of the checkoff on beef demand is important, yet it needs to be viewed along with other less quantitative aspects of the program in order to completely judge the success of the checkoff.

Econometric models are used to determine the linkage between the generic promotions and beef demand. Econometrics is a scientific approach to measuring demand and a powerful tool for empirically measuring the factors influencing demand. Even so one must always recognize the limitations of these models especially when the data do not fully reflect the complexity of events. For example, the benefits of nutritional education that sometimes are a part of generic promotions are not measured. Or individual exposures to media messages are seldom known.

In the following analysis the demand for beef is modeled with the primary goal to measure the impact of the beef checkoff on demand. The results are rich with implications but one still must recognize that the industry is far more complex than what can be fully captured in a few equations. That in no way diminishes the importance of the estimates but simply acknowledges other things beyond those quantified are also important. These type models seldom account for proactive efforts that prevented something from happening in the first place and, if those benefits are there, they are not measured within the demand structure.

The research was conducted in total and directly by this researcher where each stage of the research from the data collection to the final writing were completed independently of the beef board and advertising agencies responsible for the beef promotions. The analysis benefitted from a peer review from Barry Goodwin and Ted Scheoder. The peer reviews was intended to strengthen the analysis and does not mean every aspect of the analysis was endorsed as is seldom the case with such reviews. Many comments were technical in nature and will be reflected in more technical papers.

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Beef Demand and the Estimated Rate-of-Return to the U.S. Beef Checkoff:
An Application of Two Independent Approaches

Ronald W. Ward

(1) Introduction

The concept of beef demand is often used to reflect the underlying conditions of the beef industry since demand is a direct measure of consumers' preferences for the product. Demand is not how much is consumed nor it is just a measure of how much is spent. Rather, one needs to think of demand as a measure of purchasing behavior after accounting for prices and other factors that play some role when making the buying decisions. Beef demand can drop while the industry still sees a rise in total pounds consumed. Similarly, beef demand could rise while total expenditures on beef decline. To illustrate the concept and to facilitate the primary task of this report, the basic concept is illustrated in Figure 1.

Beef demand is the relationship between beef prices at a point in time and the quantity purchased in the same period as shown with the price and quantity points along D_1 in this figure. Note the demand is not necessarily a straight line since the price quantity relationship can change, depending on the consumption level and/or prices. These coordinates exist for a set of conditions ranging from characteristics tied to the buyer to conditions influenced by the industry such as promotions. Holding these conditions fixed, then the demand for beef is mapped as prices and quantities change, that is, movement along D_1 (e.g., movement from (a) to (c)). Any point on this demand curve includes both the intensity of consumption

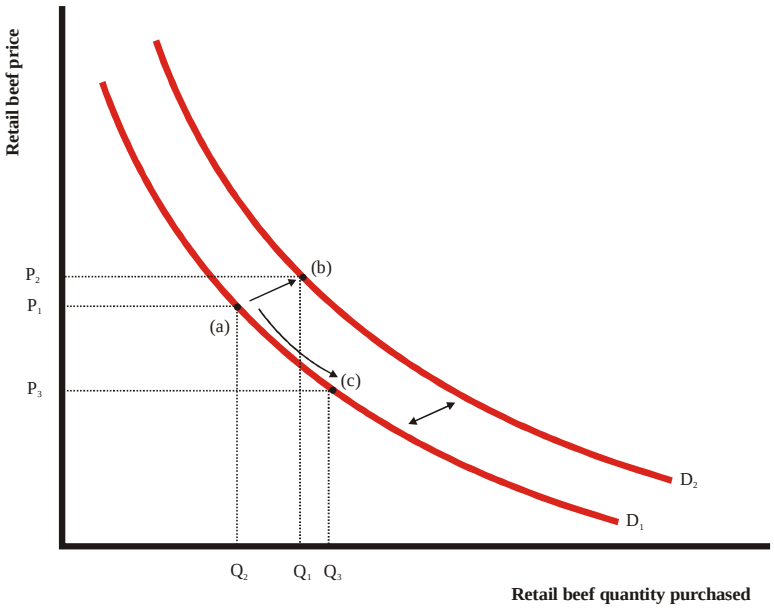

Figure 1

and the level of market penetration. The total quantity demanded reflects the amount of consumption per persons and the number of people (or households) who are beef consumers. Hence, changes in demand should be viewed in terms of both market penetration and consumption frequency (or intensity) (Ward, Moon and Medina, 2002).

A shift to D_2 is an increase in demand and may be due to greater market penetration and/or consumption intensity. For example, promotions, if they were effective, could attract new consumers and/or increase the level of use among existing consumers. Both contribute to the shift from point (a) to point (b) as one possibility in Figure 1. Generic promotion is one instrument under the control of the beef industry that could potentially lead to a shift from D_1 to D_2, again only if the promotions were effective. The effectiveness is a research question and a primary focus of this paper. Those gains depicted with movement from (a) to (b) may be totally attributed to greater market penetration or some combination of market penetration and buyer intensity. If one could determine the impacts on penetration and intensity, that would greatly facilitate designing appropriate promotion strategies.

One can equally view the demand in the opposite direction where it shifts from D_2 to D_1 because of, say, food safety concerns or problems with quality control. Consumption may drop off and consumers exit the market by simply not buying beef. Recent concerns about BSE had the potential for causing such a leftward shift ((b) to (a)) if the industry had remained passive. The point is that some factors, while not initiated by the industry, call for preventive actions to stop or lessen the shifts from occurring. Often the effectiveness of preventive actions is most difficult to measure simply because we never see the shifts from (b) to (a) that was prevented in the first place. At the juncture, the important factor is that there exist demand drivers under the control of the beef industry that have the potential to produce the (a) to (b) shifts and to stop (b) to (a) shifts. Maintenance of a strong food safety program is a case in point for the latter.

Beef demand also changes with events and circumstances where the industry has little control or input. Activities by competing industries, changing demographics, new political and/or regulatory policies, new technologies, cultural norms and fads, and health concerns may change with little to no control by the beef industry. That is, the industry may simply have to accept these changes. Then, the critical factor is to know the direction and magnitude of the impact and if anything can be done if needed. A good example would be consumer concerns

about health issues and, specifically, cholesterol. Conceptually, one might expect beef demand to shift from (b) to (a) with this health-related factor.

In Figure 1 movements along the demand curve are shown comparing points (a) to (c) or vice versa. In this example, prices have declined for some reason not identified and the consumption of beef increases form Q_1 to Q_3. In relative terms these changes are often expressed as elasticities or a percentage change in price produces some percentage change in quantity demanded. Immediately one can calculate the total retail expenditures on beef by simply multiplying $P_i \times Q_i$ and then compare changes in retail expenditures with another point on the demand curve such as $P_j \times Q_j$. It is well known that differences in the revenues over the price ranges depend on the slopes along the demand curve. Further the change from Q_i to Q_j is inherently tied to the market penetration and consumption intensity.

Using Figure 1 for reference, the focus of this paper is to explicitly measure the demand for U.S. beef and to quantify the impact of a range of demand drivers, including the beef checkoff. Has the beef industries' national promotion checkoff had a measurable impact on the demand for beef? If so, how does it impact market penetration versus consumption intensity? Secondly, what are the major demand drivers and how do these drivers compare to the checkoff? Finally, even if the promotions show a shift similar to that suggested with points (a) to (b) in Figure 1, the cost of achieving the gains may be too large. Given this basic demand representation for beef, the most fundamental question is what drives the demand? What causes demand to differ either across households and/or over time?

Generic promotions through the beef checkoff program are one of those demand drivers of primary interest. The beef checkoff has existed since 1987 and more than a billion dollars have been collected with most of the monies going to efforts to shift beef demand as illustrated in Figure 1. Have these generic promotions had a measurable impact? What impact do they have on market penetration compared with consumption intensity? One cannot address the impact of the checkoff in insolation of the other demand factors since they are all occurring at the same time. There is not a controlled experiment where everything except the promotions are fixed and then the promotion treatments observed. Rather, both entry and product use are measured in the marketplace of consumers faced with all of the conditions influencing their decisions to buy beef. The task then is to measure the buying decisions and obtain either quantitative or qualitative values for those demand factors likely impacting the

consumption decision. This is the process of demand modeling. Most of the technical aspects of the demand modeling will be reported in various appendices while the text will concentrate on the results and conclusions.

Since a controlled experiment is not an option, one must turn to collecting data from the points of decision making (i.e., the consumer or potential consumer.) If interest is in market penetration, information about those who did not consume beef is essential. That is, any data collected must not be limited to just beef users. Furthermore, the data need to be as current as possible in order to capture the more recent checkoff activities. It is also beneficial if the same issues could be addressed with different databases in order to make sure any conclusions are not tied only to that one data set used in the analysis.

Two independent databases have been adopted to provide the information necessary for measuring the demand for beef in the U.S. First, a consumer household panel diary maintained by a private company provides current and historical information about household beef buying habits. These monthly data cover the years from 1984 to 2003 with thousands of households reporting their actual buying habits (or lack of). Buying habits differ across households and over time and that variation is the essential ingredient for measuring the demand as depicted in Figure 1. Second, for any given time period, public data on the retail and wholesales movement of beef within the U.S. are available. These data are aggregated over the households so one cannot measure the impacts of many of the demographic type variables that change from household to household. At the outset we will name the two independent data series as *Servings* and *Time Series* data. More details on each will follow throughout the discussion and in the appendices.

(2) Major Beef Use Trends Among Consumers

Before turning to the primary task of measuring the demand for beef depicted in Figure 1, it is useful to have an overview of several important trends in the purchases of beef. Figure 2 includes four statistics plotted on a quarterly average basis with the upper most chart showing the quarterly retail pounds of beef consumed per capita since 1985. Next the quarterly average per capita retail nominal expenditures are plotted for all expenditures whether at-home or away-from-home. Chart three in Figure 2 measures the at-home use of beef expressed in terms of the average number of servings of beef per capita included in the diet in a typical two-

week period. Servings are the number of times beef is included in the household diet in a two-week period. Later the linkage between pounds and servings will be shown. Finally, the last chart gives insight into market penetration by measuring the percent of the U.S. population including beef in their diet in a typical two-week period. For example, a value of .80 means that 80 percent of the households include beef in their diet at some point in an average two-week time span.

Each chart in Figure 2 shows use patterns without any reference to what caused the levels and/or changes over time. These values reflect the composite effect of all demand drivers after consumers have made their decisions. Likewise, these trends do not show what would have been in the absence of certain demand factors. For example, they do not show what would have been the value without the beef checkoff or without controls on food safety issues. Measuring the impact of the many demand drivers that contributed to these use values

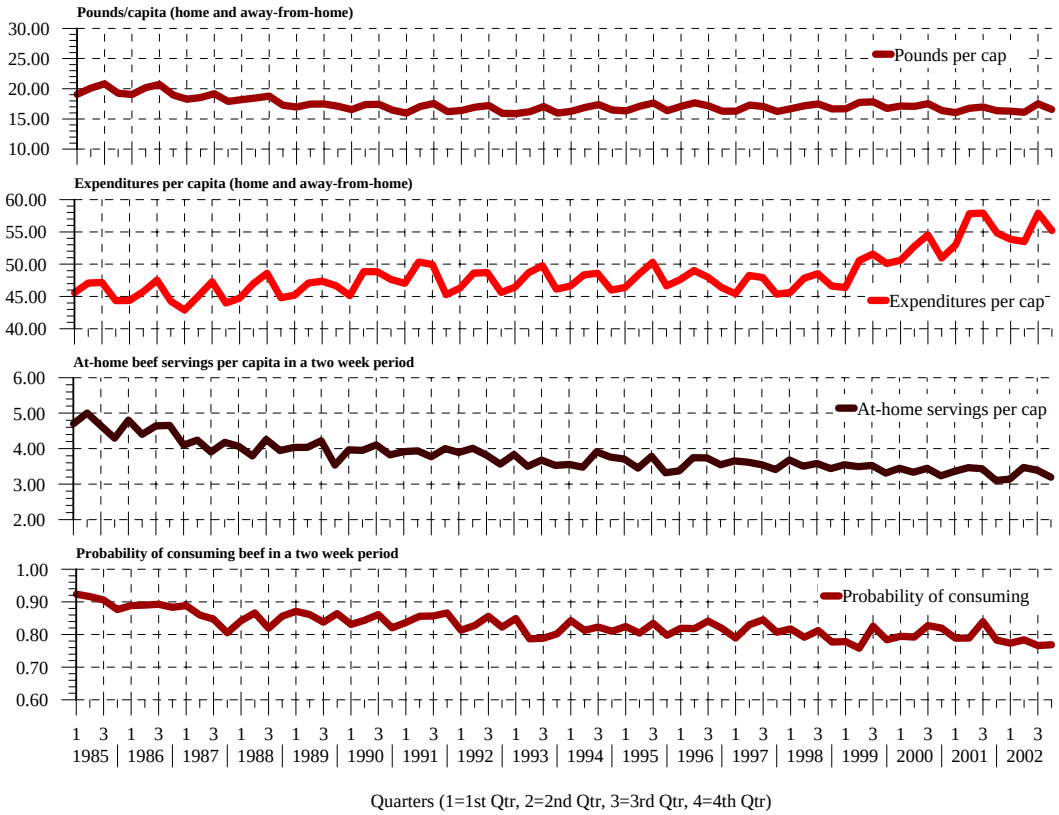

Figure 2. Basic consumer trends in beef use with a consumer being expressed as the proportion of households serving beef in a two-week period (wave).

is accomplished using several statistics tools developed later in this report and in the appendices.

Total retail per capita pounds of beef generally trended down up to the early 90's and then fluctuated around the 16.5 to 17.0 pounds per capita level. In contrast, quarterly retail expenditures ranged between $45 to $50 per capita through most of the 90's up to 1998. Starting in 1999, the expenditures per capita trended upward from $46 in 1999:1 to $55 in 2002:4, reflecting the rising value of cattle over these later quarters.

The bottom two charts focus on the at-home beef use by showing both the intensity and market penetration. As a general rule, around 75 to 80 percent of the U.S. households report some use of beef in the average household diet in a two-week period. The general small negative trend clearly points to some decline in market penetration with fewer households recording some beef consumption. Equally important from the industry standpoint is that at least 75 to 80 percent show some use of beef. Finally, the servings trend over the decade points to declines in the number of servings of beef included in the household diet within the two-week time span.

The pounds and expenditure charts are drawn from aggregate market data while the servings and probabilities are from direct consumer household data. Since the household data are directly from the decision makers and that we know the demographics of those households, measuring the demand with these data is particularly useful. Hence, in the subsequent analysis the focus is first on the servings type information then followed with the aggregate time series analysis. In both cases, the goal is to measure the impact of major demand drivers with emphasis on the impact of the beef checkoff on the pounds of beef consumed, the servings included in the household diet, and the levels of market penetration (NPD, 2003).

(3) U.S. Beef Checkoff

Consumption decisions are based on the value of the product, household and/or consumer needs and preferences, and the amount and quality of information available when planning and making buying decisions. Information through promotions may contribute to both spontaneous and planned buying decisions. Spontaneous decisions are based on information that produces a high recall and stimulants, whereas planned decision may draw

Table 1. At-home servings database - variable descriptions.

Variables, descriptions and scales

Demographics:

1. Wave Number;
2. Demographic House Hold Size (1=1 Member, 2=2 Mem, 3=3/4 Mem, 4=5+ Members)
3. Market Size (1=1 Mil+, 2=500/999 Mil, 3=250/499 Mil, 4=50/249 Mil, 5=rural)
4. Children under 18 Years (1=yes, 2=no)
5. Employment of Female Head (1=employed, 2=not Employed);
6. Age of Female Head (1=<35, 2=35/44, 3=45/54, 4=55/64, 5=65+)
7. Education of Female Head (1=no High S, 2=high S, 3=some College,4=college graduate)
8. Census Region (1=ne, 2=ma, 3=ecn, 4=wnc, 5=sa, 6=esc, 7=wsc, 8=mtn, 9=pac)
9. Household Income (1=under $10000, 2=10/19999, 3=20/29999,4=30/39999, 5=40/49999, 6=50/59999, 7=60/69999, 8=70/99999,9=100000+)

Behavior:

Children on Diet (Yes/No) Adult Male on Diet (Yes/No) Adult Female on Diet (Yes/No)

Attitudes:(six point Likert scale - Agree=1 to Disagree=6):

Avoid Snacking Entirely	Avoid Fried Food	Avoid Foreign Food
Like to Bake Frequently	Check Labels	Doctors Gives Advice on Diet
Importance to Eat Regular Meals	Love to Swim	Overweight Isn't Attractive
Conscious of Calories	Like to Lose 20 Pounds	

Know More than Most	Plan Nutritious Meals
Children Should Not Eat Sweets	Vitamins Recom.. by Physician
Food Should Have Body Building Ingredients	Always Keep Some Fruit Around
Should Be Cautious about - Sugar	Should Be Cautious about - Cholesterol
Should Be Cautious about - Additives	Should Be Cautious about - Fats
Should Be Cautious about - Salt	Should Be Cautious about - Preservatives
Should Be Cautious about - Caffeine	Important for Food to Be Fresh
Depend Mostly on Can Food	Best Known Brands Are Highest Quality
Important Food Looks, Smells, Tastes Good	Everything Good Doesn't Taste Good

Attitudes:(six point Likert scale - Encourage=1 to Discourage=6):

I encourage (discourage) the consumption of:

Hot Dog Sandwich	Granola Cereal	Beer
Wine	Whole Milk	White Bread
Rice	Skim/low Fat Milk	Margarine
Caffeinated Coffee	Pre Sweetened Cereal	Turkey
Pizza	Lunchmeat	French Fries
Tacos	Fried Chicken	

on the information providing greater detail about the product. Advertising and promotions can provide both types of information, depending on the design, timing, and medium used (Forker and Ward). Consumers considering food products, unlike durable goods, are expected to have greater potential for spontaneous buying along with planned purchases. Promotions through the beef checkoff have the potential for both types of impacts by stimulating spontaneous buying as well as providing information for planning meals. Any impact, however, must be determined empirically while accounting for other factors that influence beef demand at the same time.

For the quarters from 1987:1 through 2002:4 assessments from the beef checkoff totaled approximately $1.31 billion. By law half of the initial assessments remain at the state levels for state promotion programs. However, there is nothing to preclude the states transferring some of their funds to the national level. Assessments on imports also contribute to the total assessment base. In Figure 3, 54.6 percent of the checkoff funds were used at the national level and 45.4 percent by the states. We know the distribution of the national dollars and must implicitly assume that the state efforts build on and parallel the national efforts. There are no consistently complied data from each state's programs that are readily accessible. For the national level, nearly 76 percent of the monies go directly to domestic demand enhancing efforts (including national advertising primarily through television), consumer information programs and industry information activities. All of these are intended to shift the demand for beef as suggested in Figure 1. With the inclusion of

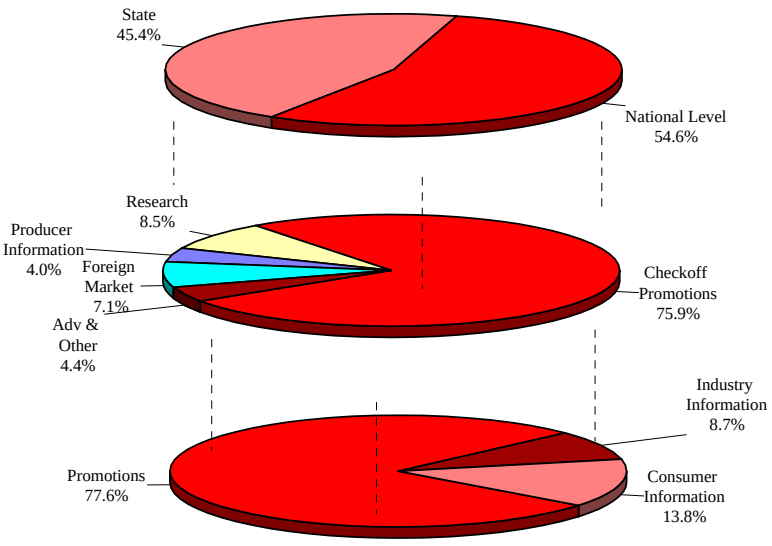

Figure 3. Distribution of the beef checkoff dollars.

foreign market development, almost 83 percent of the checkoff funds are for directly impacting beef demand. New product research and related research issues account for 8.5 percent of the total assessments while communication back to producers require about 4.0 percent. Note that the administrative and oversight cost is less than 5 percent of the total.

Finally, 77.6 percent of the domestic demand enhancing efforts are through direct media advertising as shown in the bottom pie in Figure 3. Clearly, the national media efforts account for the bulk of the checkoff assessments. There has been considerable quarter to quarter variation in the promotion expenditures over the life for the beef checkoff and that variation is essential if the impact of the programs is to be measured. The relative expenditures on media advertising, consumer information, and industry information have shown less variation and that factor makes it more difficult to separate out the impact of the advertising contrasted with the consumer and industry information programs.[1] Hence, in subsequent models most of the impacts are in terms of the aggregate instead of the separate effects of each part of the demand enhancing programs (Cattlemen's Beef Promotion and Research Board).

(4) Measuring Retail At-Home Demand for Beef - Servings Analysis

To measure the demand shown in Figure 1 one must (a) determine the level in the marketplace where the demand is to be measured (i.e., retail, wholesale, or liveweight), and (b) acquire the data that capture buyer behavior at that level. Since most of the checkoff promotions target existing and potential beef consumers at the point of purchasing for personal consumption, it is useful to have buyer data at that decision point. Over the years the beef board has acquired household data from a private vender. These data report, on a nearly equivalently monthly basis, the number of servings of beef each household includes in the family diet within a two-week period. These are servings instead of pounds of beef, but later

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Technically the coefficient of variation for the checkoff promotion expenditures is 1.366 while the CV for the advertising share of the total is .1606. There is considerably more variation in the total effort and much less variation in terms of how the dollars were allocated to advertising versus the consumer and industry information efforts. This immediately implies that measuring the impact of the total is likely to be more successful than trying to separate out the effects of just advertising contrasted with the informational efforts.

the linkages between pounds and servings will be shown. The typical question is ... *how many servings of beef did you include in your household during a particular time period defined as a wave?* Since we know the number of members in the household, the servings are easily expressed on a household member basis. Figure 2 (third chart) included the average servings over a quarter and those averages were derived from the household reports. Some households reported no servings of beef within the wave (time period) while others reported some level. Beef consumers are defined as any household who served at least some beef within a wave, otherwise they were treated as non-consumers for that period. There are 36,099 households in the full data set with the reports extending from 1984 through the 1st quarter of 2003. Comparing the total beef users (i.e., served some beef) to the total number of reporting households provides a direct measure of market penetration as also shown in Figure 2 (last chart). Using these data, both the market penetration and buying intensity (servings) can be used to measure the demand for beef as expressed with D_1 in Figure 1. With the appropriate empirical tools, the shifts in demand from D_1 and D_2 can be shown and, specifically, if the beef checkoff had a measurable impact.

Beef demand should differ across consumers depending on the characteristics of the consumer, market conditions, and information. Household characteristics within the servings data are categorized into demographics, behavioral practices, and attitudes. The behavior and attitudes are measured through a series of questions answered by the household head using a standard scale to reflect the level of agreement or disagreement and the degree that the household encouraged or discouraged specific types of consumption behavior. Table 1 (page 9) shows these categories and data scale.

The first section in Table 1 identifies major demographics for each household with the codes noted. Dieting behavior is shown next followed with specific opinions about eating habits, health concerns, food knowledge, and exercise. These are scaled in terms of the degree of agreement or disagreement to the questions. For example the statement could be... *I should be cautious about cholesterol*. The degree of agreement or disagreement is then assigned with the six point scale. Finally, the last section uses a similar scale for the degree of encouragement for the family to eat various types of foods such as ... *I encourage (discourage) eating pizza.* These last attitudes are intended to identify household concerns with certain types of foods that may or may not be healthy.

What is missing in the servings data are prices for beef and competing meats and the degree of exposure to advertising and promotions. The media exposure is almost always missing from these types of data. Since the servings data are recorded over several quarters starting with 1984, the average prices for beef and other meats from other sources can be matched with the appropriate waves to provide a general price indicator. This is reasonable since most beef price variability is probably greater over time and likely less variable across consumers. Second, the checkoff efforts target most households and there is no direct way to know if a specific household in the data set saw a particular commercial. We know the periods when various checkoff promotions took place and can match these checkoff efforts to the appropriate periods within the servings database.

The variables as described in Table 1 along with meat prices and the checkoff expenditures provide the database for empirically showing the effects of major beef demand drivers, including the beef checkoff. Once the servings models are estimated one can, for example, show the impact of health concerns on beef demand, the impact of demographics, and foremost to this analysis, the impact of the beef checkoff. While the technical details of the models are in Appendix A, it is useful to lay out the model structure in the text (Long; Davidson and MacKinnon).

Visualize two models, one showing the likelihood of being a beef consumer and the other the amount used if you are a beef consumer. Define the probability of being a beef consumer as Prob and the amount used as Ser. In equation (1a) and (1b) these measures are shown as some function of the variables described above.

$$\text{Prob} = \left\{ \begin{array}{l} \text{Demographics; Attitudes;} \\ \text{Behavior; Preferences; Prices; Checkoff} \end{array} \right\} \qquad (1a)$$

With equation (1a) the probability of being a beef consumer is estimated for any combination of variables included in the model. For example, if checkoff dollars were increased for a low to high level then, with this equation, the corresponding change in the likelihood of consuming beef is shown. That is, how much does the market penetration change with the promotions? Similarly, (1b) shows the servings for any set of variable values. Reference back to Figure 1, the magnitude of the shift from (a) to (b) would be known depending on the level of the

checkoff effort. While the technical details are reserved for the appendix, three important

$$\text{Ser} = \left\{ \begin{array}{l} \text{Demographics; Attitudes;} \\ \text{Behavior; Preferences; Prices; Checkoff} \end{array} \right\} \qquad (1b)$$

aspects of the model need to be raised once the models have been estimated. First, do we have the correct demand drivers in the model? Second, are the empirical values for the estimated effects reasonable? Third, do we have confidence in the estimates? Each of these will be alluded to throughout the discussion while emphasizing again that the technical models are presented in the Appendix A. In the following sections the models estimated in Appendix A are used to show the impacts of the beef checkoff and many other factors impacting U.S. beef demand. The text focus is on the results while the appendix is on the process.

(5) Market Penetration, Servings and Retail Beef Prices

In this section the relationship between beef prices and the at-home consumption of beef is shown using the beef servings model. While the data base includes the full range of households based on demographics and the other factors noted in equations (1a) and (1b), the price/quantity relationship first shown in Figure 1 is estimated for the average consumer. For the typical household what does the demand relationship look like using the average characteristics for the 2000/2002 period?

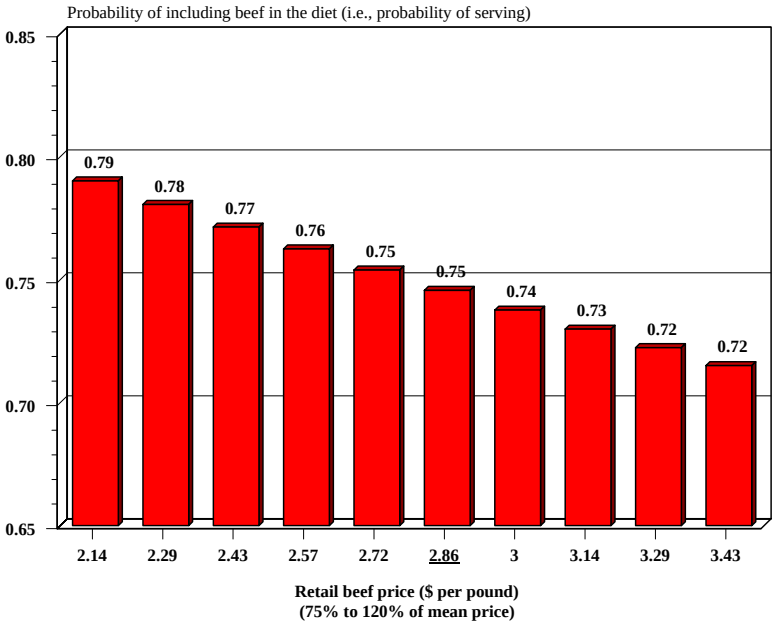

Figure 4. Probability of buying beef for the average household - 2000/2002.

Prices clearly have an impact on the likelihood of consuming beef as shown in Figure 4, page 14. Average retail beef prices are plotted on the bottom axis of this figure and the probability of

consuming beef is on the vertical axis. The absolute level of the probability again depends on if you are viewing the average household or a specific set of characteristics. The relationship between prices and the probabilities should remain similar over the various cross sections of households.

As set forth in Figure 4, prices are adjusted from 75 percent of the mean price to 120 percent of the mean price with the mean retail price for all cuts being $2.86 per pound. Over these prices, the level of market penetration is around 79 percent for the lowest price and then declines to near 72 percent for prices near the $3.43 value for a range of about 7 percentage points. *As a general rule, for each 5 percent increase (or decrease) in the retail beef price from the mean price, the probability of consuming beef declines (increases) from .7 to 1.0 percentage points.* The amount of change depends on exactly where you are on the demand curve. Statistically, we have more than a 95 percent confidence level in this relationship (see Appendix A, Table A.2).

Next, once becoming a beef consumer then the question is directed to the level of consumption. Using the same assumption as above and the models from Appendix A, the relationship between at-home beef servings and retail beef prices is shown in Figure 5. Statistical confidence in the price/servings relationship exceeds the 95 percent level. Servings at the mean retail price of $2.86 per pound and for the typical household is 3.53 servings per household member in a typical two-week period. These beef servings range from 3.72 down to 3.42 for a difference of approximately .30 servings per capita for the selected price range. Over the prices shown in Figure 5, *for each 5 percent change in the retail prices, one can expect a .03 to .04 servings change.*

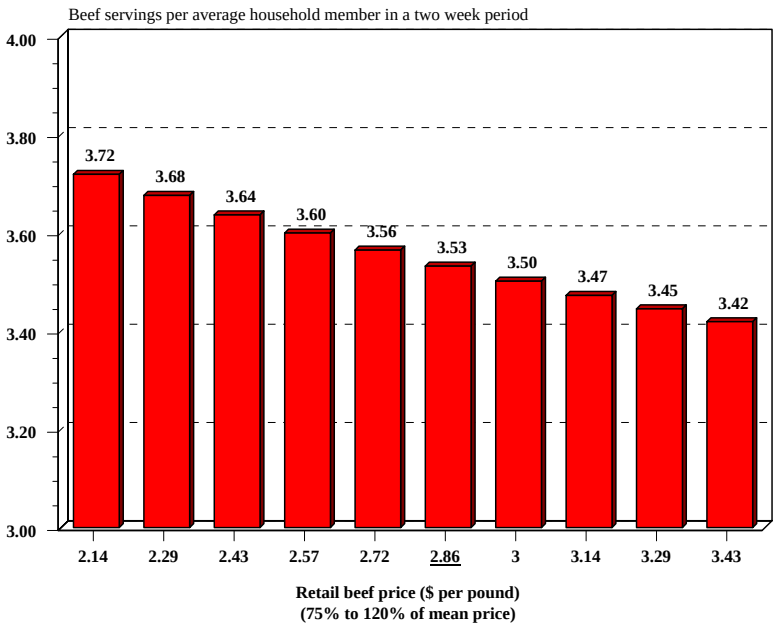

Figure 5. Relationship between beef servings and price.

Again, Figure 5 is for the typical household where the absolute servings levels will rise and fall as other demand drivers are adjusted as will be shown later.

(6) Market Penetration, Servings and the Beef Checkoff

Using the servings data and the results shown in the previous two figures, it is now clear that the demand for U.S. beef can be estimated and, thus, giving the demand response D_1 first shown in Figure 1. Using this model the most important question for this analysis is if the beef promotions had a measurable impact on beef demand (i.e., did the beef checkoff lead to shifts in demand from D_1 to D_2 in the Figure 1?) The beef checkoff activities were included in the demand models by expressing the expenditures on promotions and consumer/industry information in terms of real dollars per capita. In Appendix A two models are presented and the results from the first model are used here. On average approximately 8.5 million dollars per quarter were spent at the national level and a similar amount at the state level. In the models reported in Appendix A, these checkoff efforts are shown to be statistically significant with confidence levels exceeding 95 percent. Specifically, see the t-statistics for the checkoff efforts with values of 4.24 for the impact on the likelihood of buying beef and 2.48 for the servings. *For both the market penetration and the number of servings included in the diet, the statistical evidence is clear that the beef checkoff had a positive and statistically significant influence on the demand for beef in the U.S.*

Greater insight into the checkoff impact can be seen when using the models to show the estimated shifts in demand over different checkoff expenditures levels. In Figure 6, national checkoff expenditures are plotted and the resulting probabilities of including beef in the household diet are shown

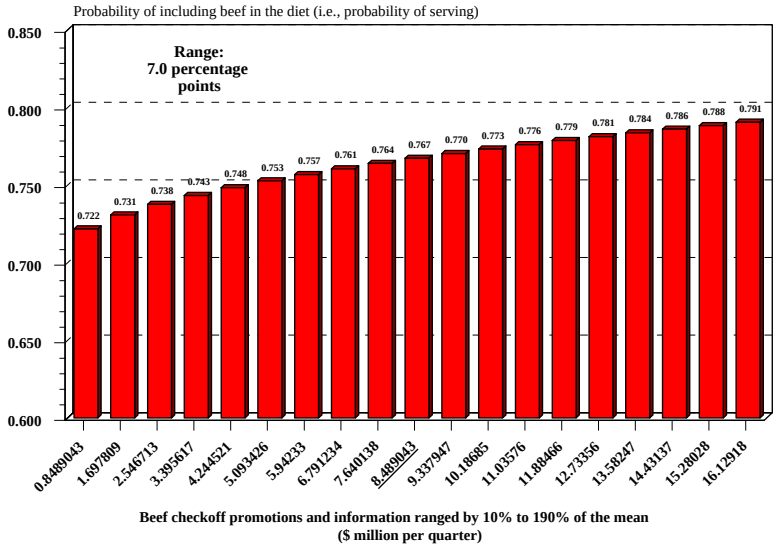

Figure 6. Impact of the beef checkoff (national $) on the probability of buying beef.

on the vertical axis. The upward slope in the bars points to the positively measured impact of the beef checkoff on the likelihood of serving beef. For the lowest level of checkoff activities shown, the probability of including beef in the diet for the average household is 72 percent. This probability increases to 79 percent for the highest checkoff effort in Figure 6, giving a range of nearly 7 percentage points. That is, over the wide range of checkoff expenditures shown, the maximum expected change in the level of market penetration is around 7 percentage points. Obviously, for smaller adjustments in the promotion dollars the range of change will be smaller. Figure 6 establishes empirically that the beef checkoff has had an impact on attracting consumers to the market but the range of change is limited. That is reasonable and expected since most households already include some beef in their diet. *Within a 10 to 20 percent range in the adjustments from the mean checkoff expenditure level, one can expect that for each 10 percent change in the promotions market penetration will change by about .04 percentage points.* Beyond the statistics, that range seems reasonable in that it becomes increasingly more difficult to increase the level of market participation when the absolute number is already quite high.

Following the format in Figures 5 and 6, the servings can be estimated over the same range of checkoff expenditures. Holding all demand drivers to the average for the 2000/2003 period, Figure 7 shows a positive and statistically significant response to the beef checkoff in terms of servings of beef included in the household diet for a typical two-week period. At the mean national level and for the average household, use of beef is estimated to be 3.62 servings per household member in a two-week period. Compare this to the average servings over time shown in the third chart in Figure 2.

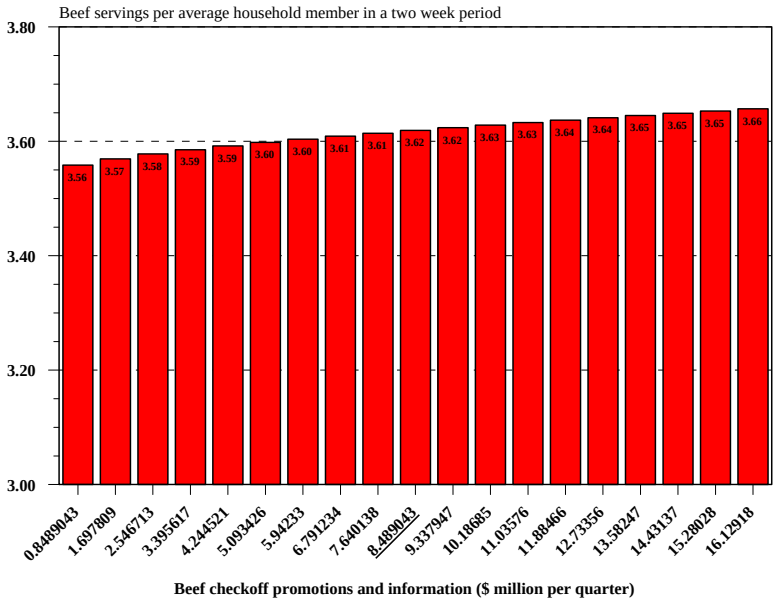

Figure 7. Servings response to the beef checkoff.

Again setting a general rule, the models indicate that ... *for each 10 percent change in the beef checkoff efforts, beef consumption changes by about .004 servings per capita.* Note also in Figure 7 that the full range of change in expected servings is around .10 servings. That is, the maximum impact of the beef checkoff on the use of beef at-home is around .10 servings per household member. The combined impact of the beef checkoff through attracting more consumers and through increasing the number of serving both contribute to a numerical shift in the demand for beef first illustrated in Figure 1 with the shift from D_1 to D_2.

(7) Beef Demand - The Full Picture

Movements along the demand curve were captured with the price/servings relationship and shifts in demand shown with the promotions/servings response. In both cases, the numbers were for the average or typical household for the more recent years. Movement along the beef demand curve and shifts in the demand for beef can be combined to illustrate a full picture of the demand for beef, again for the average household. In Figure 8 beef servings are shown on the vertical axis while beef prices and checkoff assessments (national and state efforts) are recorded on the bottom left and right axis. This surface is the demand for beef letting both prices and promotions change while holding all other demand drivers fixed. The negative relationship between the quantity demanded and prices is seen with the downward sloping surface on the left side of the figure. Similarly, the smaller positive slope shows the demand response to the beef checkoff. If this right response were perfectly flat we would conclude that there is no response to the beef promotions. With the positive response the issue is if the magnitude of change is numerically meaningful. This will be addressed later. Statistically both the negative price response and the positive response to the promotions are shown to be significant, carry the correct signs, and are numerically reasonable.

Figure 8 provides a true picture of the demand for beef after accounting for many of the factors impacting the use of beef. It is important to visualize that this demand surface will shift up or down depending on other demand drivers. For example, a BSE crisis could shift the demand surface down considerably. Or, new product developments or growing incomes could raise the surface. The full range of other demand drivers would simply lead to shifts up or down in this demand surface, depending on what drivers are changing and the direction of change. Also, the surface is for the at-home demand at the household level. Theoretically,

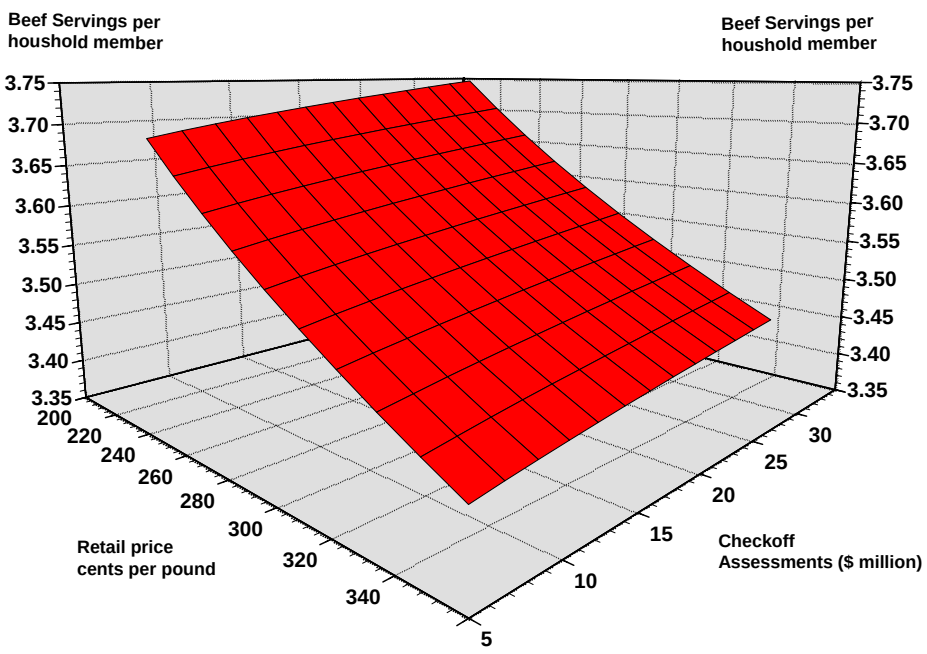

Figure 8. Movements along and shifts in the demand for beef.

there exists a similar surface below this one that captures the demand for beef at other points in the vertical market system for beef. In particular, when calculating the value of the impact of the beef checkoff, that value needs to be expressed at the producer level.

(8) Value of the Beef Checkoff - Marginal Responses

To determine the benefits of the response to the beef promotions, one obviously must express the demand gains in terms of their dollar value. A significant problem with the servings data is that the quantity gains are in servings and not pounds of beef. Some method for converting the servings to an equivalent pounds basis is needed in order to calculate the financial gains from the checkoff. It is very possible that the shifts in demand as shown are positive and significant but the financial gains of little consequence to producers. That must be determined after mapping servings to an equivalent poundage basis. To do this mapping, the pounds and servings charts presented earlier in Figure 2 can be used. To make the conversion it is assumed that for the quarters 2000:1 through 2002:4, the away-from-home beef consumption accounted for 50 percent of the total beef consumed.

From Figure 2 the total pounds per capita are known from reported public data. These are the pounds divided by the total population, not just the population consuming beef. Approximately 50 percent of these pounds are assumed to be consumed at-home. Next the servings per member in a household using beef (also shown in Figure 2) are derived from the serving data. Since the pounds are expressed relative to the total population, the servings need to be in equivalent units by multiplying the reported servings by the percent of households consuming beef. This gives the equivalent servings per capita. Finally, dividing the total pounds per person by the equivalent servings per person gives the equivalent pounds for per servings of beef. Using the USDA average pounds per capita for the 2000:1 through 2002:4 period, the average pounds per servings of beef is estimated to be .52 pounds.

With this weight, one can immediately express the servings on a pound basis and then

$$\begin{pmatrix} Pounds \\ per\ Servings \end{pmatrix} = \left(\begin{pmatrix} Avg.\ Pounds \\ per\ Person \end{pmatrix} \times \begin{pmatrix} Percent \\ Away\ from \\ Home\,(.50) \end{pmatrix} \right) \div \left(\begin{pmatrix} Servings \\ per\ Hwd\ Member \\ when\ consuming \end{pmatrix} \times \begin{pmatrix} Percent\ of \\ Households \\ Buying \end{pmatrix} \times 6 \right) \quad (3)$$

$$\begin{pmatrix} TotalPounds \\ for\ the\ Quarter \end{pmatrix} = \left(\begin{pmatrix} Avg.\ Pounds \\ per\ Serving \end{pmatrix} \times \begin{pmatrix} Servings \\ per\ Buying\ Household \\ Member \end{pmatrix} \right) \times \left(\begin{pmatrix} U.S. \\ Population \\ by\ Quarters \end{pmatrix} \times \begin{pmatrix} Percent\ of \\ Households \\ Buying \end{pmatrix} \times 6 \right) \quad (4)$$

derive the corresponding value since prices per pound are known. As outlined with the scheme in (4) above, the total pounds are simply the servings per member of a buying household time the percent of household buying times the population. This is then multiplied by six to express the two-week purchasing period in terms of a quarter. In order to express these pounds and retail prices at the equivalent producer level it is further assumed that a boxed beef pound is equal to 1.438 times the retail pounds (i.e. *box = retail/.70*) and that the liveweight is 1.537 that of the boxed beef (i.e., *live = box/.655*). Furthermore, box beef prices are .364 that of retail beef prices and liveweight prices are .622 that of boxed beef. Liveweight pounds then equal the (retail pounds) × 1.438 × 1.537 and the liveweight equivalent price is the (retail price) × .364 × .622. These conversions are important in that changes in the beef servings noted in Figure 8 can be expressed at the equivalent liveweight levels. That is, the checkoff promotions are adjusted as shown in the bottom right axis for different retail prices and then expressed in equivalent gains in dollar value at the producer level.

A useful way to illustrate the economic impact of the beef checkoff is to calculate the marginal gains with incremental increases in the checkoff expenditures. Marginal gains are simply showing the incremental increases in revenues with fixed increases in the beef checkoff. If the checkoff had no impact the marginal gains would be zero for any level of promotion changes. For the marginal gains to be substantial, the programs must have had an impact. With additional efforts, at some point the incremental gains should approach zero since it becomes increasingly more difficult to reach the marginal consumer. As more and more households become consumers it should take an even greater effort to entice those remaining households to become consumers. Also, if the servings levels have increased with the promotions, the cost for achieving even more servings could become prohibitive. Thus, the marginal gains with increasing promotion efforts should decline.

Marginal rates-of-return to the beef checkoff are presented in Figure 9 using the demand estimates discussed above and from Appendix A along with the conversion factors. The estimated demand models included the national checkoff dollars on a real per capita basis since that was the only generic promotion expenditure information available. Since the states have parallel programs, the coefficients associated with the national expenditures should also be picking up any impacts from these state and/or local efforts. When calculating the marginal rates-of-return it is essential that the promotion base reflect the expected total checkoff effort. The promotions or advertising and information efforts could not exist in the absence of supporting and related board activities. Therefore, in Figure 9 the equivalent total checkoff assessments are on the bottom axis and the resulting marginal rates-of-return are on the vertical axis. While several conversions are needed, it is important to recognize that none of the conversions bias the marginal gains upward (i.e, the gains are not being overstated with the conversions.) For comparison the marginal gains are illustrated with the base pound equivalent basis of .526 and then plus or minus .5 pounds per serving. While there is considerable detail in this figure, *the most important result is that the marginal rates are consistently above a value of five over a wide range of assessment levels.* For each incremental increase, the gains in total revenues net of the expenditures are at least five times the incremental costs. These gains are net revenues back to producers after covering the cost of the checkoff. Also, the model performs as expected with the rates declining with larger checkoff levels. This adds credence to the model in that it gives results that are statistically

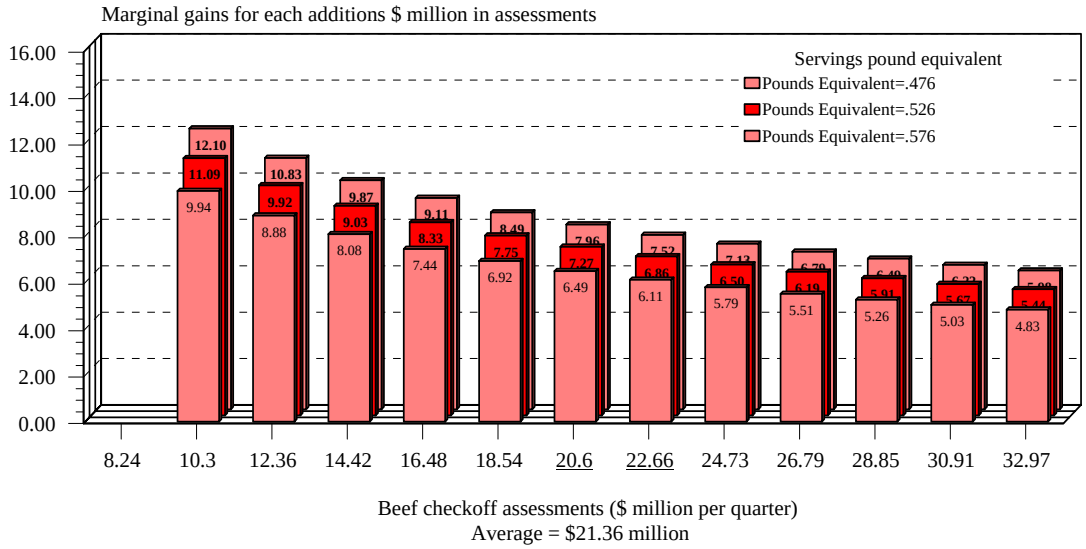

Figure 9. The marginal rate-of-return to the beef checkoff at the liveweight market level.

significant and appear reasonable within the context of the beef industry and other checkoff programs. *The large rates-of-return for the higher expenditure levels also indicate that the industry is not overspending on the checkoff.* Also, when *segmenting the marginal gains between market penetration versus increased servings among buyers, between 76 to 80 percent of the gains are attributed to market penetration within the two-week periods and the remainder from changes in the servings among those indicating some consumption level during the same period.* This is quite important in that it allows one to make better judgements about the design of new messages and who to target, e.g., existing consumers or potential entry of new consumers.

Over the years this author has cited the gains from the beef checkoff to be in the vicinity of five and these current estimates and marginal responses support that continued conclusion. Later in the report these marginal responses will be compared with another approach to the same problem.

(9) Non-Promotion Demand Drivers - the Servings Model

The impact of the beef checkoff was estimated while accounting for other factors

impacting both the likelihood of buying beef and the number of servings among existing beef consumers. Analysis of the checkoff promotions cannot be isolated without accounting for most of the other factors that could influence the household purchasing decisions. Once the impacts of other demand drivers are known, it is possible to put the checkoff effect in perspective to other factors also influencing the shift in demand initially suggested in Figure 1. That is, how important is the checkoff relative to other conditions that influence the demand for beef? In this section, we will first highlight the shifts in beef demand attributed to a range of demand drivers and then compare those demand shifts with that achieved with the checkoff shown in Figures 7 and 8. These other drivers range from demographics to health concerns and their impacts on both the probability of consuming beef and the level of servings per household member are illustrated, leaving the technical details to the appendices. A similar format is adopted for each figure, first showing the likelihood and then the servings of beef.

(9.1) ***Demographics - Servings Model***

Household demographics include measures of income, age, education, family size, and employment status of the female head of the household. Each variable is expressed in discrete categories rather than a continuous range (see Appendix A). Figure 10a through 10d illustrate four of the demographic variables. Statistically both income and the age of the female head of the household are significant and generally show the expected sign of the impacts. In Figure 10a the probabilities consistently increase over the limited income categories with a particularly large increase from 53 percent consuming beef to over 80 percent for those incomes above $20,000. Similarly the servings increase up to the $40,000 income group and then drop off. Probably a wider range of incomes should have been considered, but with these results *the analysis indicates most of the income effect is through attracting more buyers rather than increasing the level of servings.*

In direct contrast, both the probability of buying beef and the level of servings increase slightly between the younger age category (under 35 years) and the next age group. From the age group 35/44 years, both the likelihood of including beef in the diet and the number of servings among those households buying beef continue to decline with each additional age group. Reference back to the conceptional demand in Figure 1, the demand shifts from D_2 to D_1 with aging. Note the substantial decrease in servings from 3.85 to 3.03

between the 35/44 and the over 65 years of age groups. Clearly, *the demand for beef declines with age over the majority of age ranges.*

Figures 10c and 10d show the comparable effects from ranging the education level of the female head of the household and the employment status of that head. For most of these demographics when either the male or female statistics could be compared, the female is selected since it is generally assumed that the female makes most of the food purchasing decisions and meal preparations. As seen in Figure 10c, *education has a negative effect on the likelihood of buying beef and the level of servings* when actually consuming beef. This is most apparent for education since market penetration and market intensity both decline starting with the lowest education level.

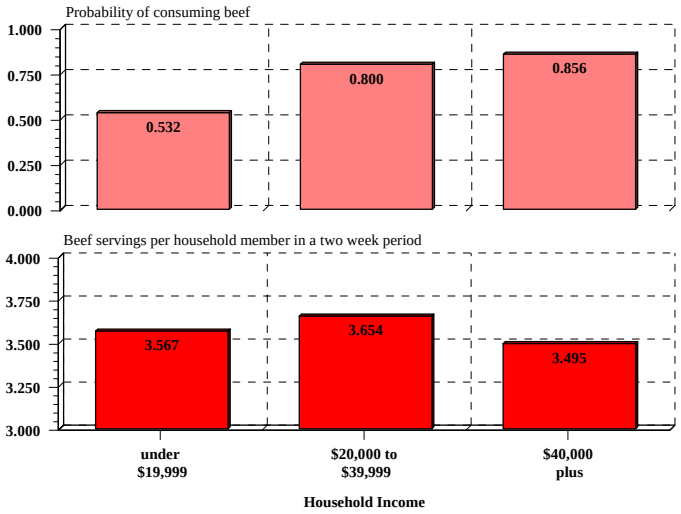

Figure 10a. Household incomes and beef servings.

Convenience is often cited as a factor expected to play a role in making the decision to include or not include beef in the diet within the two-week period. A proxy measure for convenience should be something that would place additional value to having convenient products because of time constraints. Employment status of the female head of the household is such a variable with the argument being that greater convenience is needed when the female head is employed. Results in Figure 10d confirm this proxy convenience measure with the left bars showing employment and the right, not employed. The probability of buying beef decreases from .78 to .70 when the female head is employed and, as well, servings

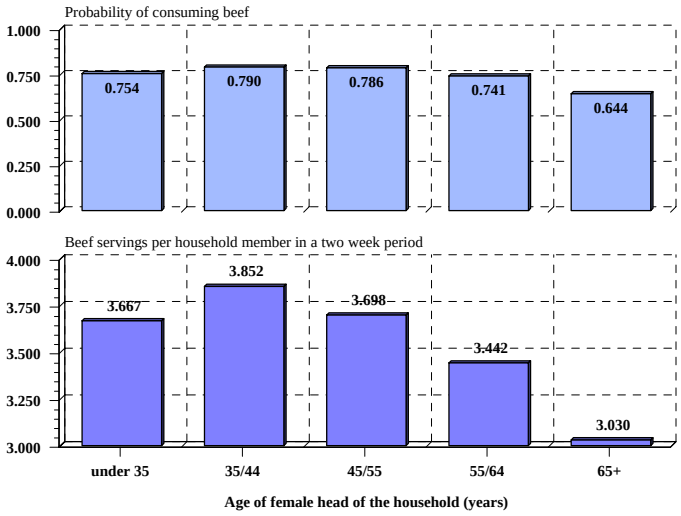

Figure 10b. Age of female head and beef servings.

decline from 3.72 to 3.35. Accepting employment as a proxy measure of the need for convenient foods, then *beef demand declines as the female enters the workforce and, hence, wants more convenient foods.*

Interestingly, three of the four demographics shown in Figure 10 consistently point to declines in beef demand over the range of each variable. Demographics are basically not controllable and the challenge to face these negative effects is apparent. More women are entering the workforce and the population is aging, thus adding to the negative pressure on beef demand. These factors are extremely important in that even with efforts to grow demand, there are still considerable negative pressures that could more than offset any gains associated with promotions. Given we now know from Figures 8 and 9 that the promotions have a positive impact, in the absence of these promotions the negative pressure from variables such as these demographics would have been even worse.

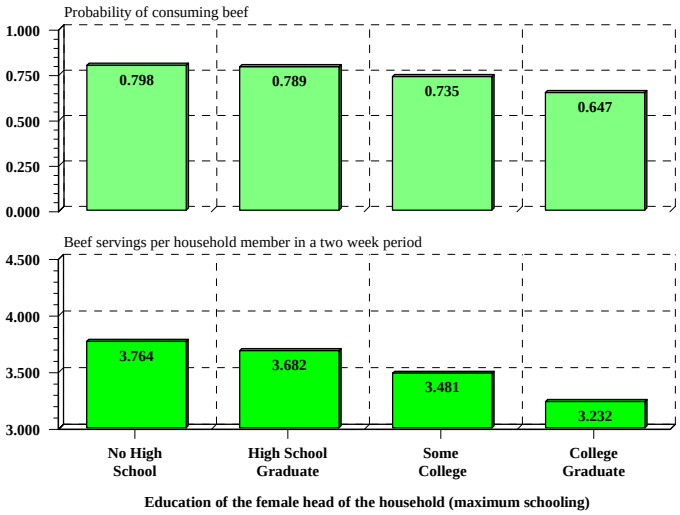

Figure 10c. Education and beef servings.

Finally, while not shown graphically there is a positive relationship between the use of beef and the size of the metropolitan area that the household lives. The relationship consistently shows an increase in the likelihood of buying beef from .70 to .78 when comparing the largest U.S. cities (over million) to the rural areas. Equally, servings increase from 3.31 to 3.80 between these city sizes. *Beef usage increases when moving away from the larger cities to the smaller towns and rural*

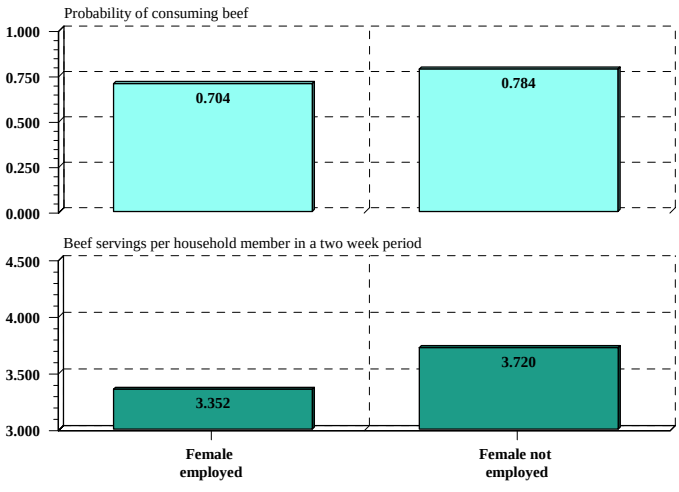

Figure 10d. Employment status and serings.

areas.

(9.2) *Health Concerns - Servings Model*

In the servings database households participating in the diary were asked to respond to several questions relating to their concerns about cholesterol, fats, additives, and other health related aspects of the foods consumed (see Table 1). These variables were included in the servings models detailed in Appendix A and we will again concentrate on the results in the text. Specifically, consumers were asked to scale their concern about certain health issues by noting their degree of agreement to disagreement with the statement that ... a person should be concerned about cholesterol or other food attributes. The expectation is that the demand for beef is likely to drop among those expressing the strongest concern. As might be expected households expressing strong concern about one health issue such as cholesterol may also indicate a strong concern for fats or other factors. Issues arising out the possible correlation among some of these health related concerns are addressed in the technical discussion of the models (again see Appendix A).

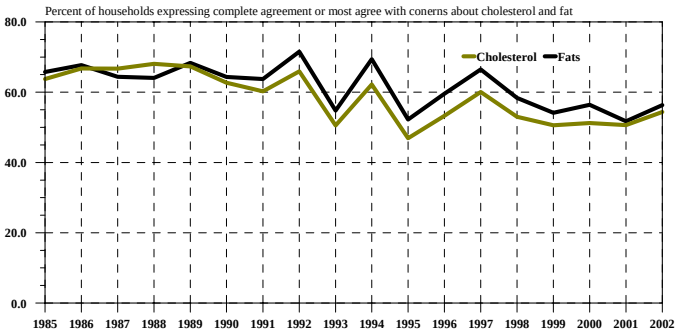

Figure 11a. Distribution of health concerns.

Figures 11a and 11b provide considerable insight into the impact of health concerns on the demand for beef where concerns about fats and cholesterol are shown in these figures. As seen in Figure 11a, somewhere in the range of 60 percent of the households express complete agreement or mostly agree with being concerned about fats and cholesterol. In the year 90's, however, the concern for both did start to decline where by 2002 the

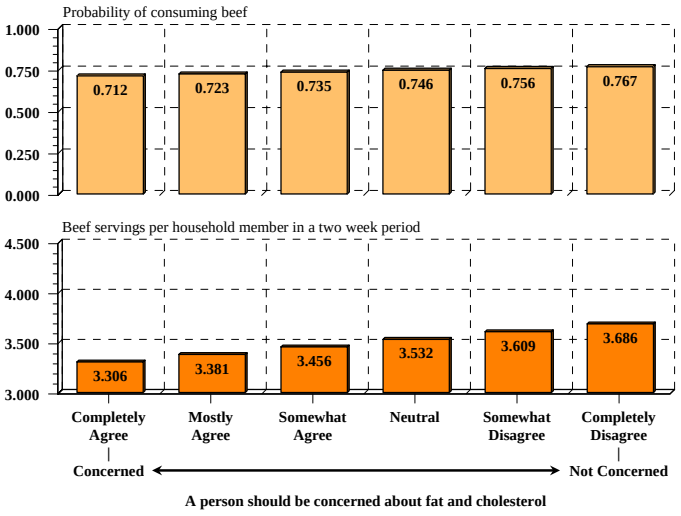

Figure 11b. Health related concerns and and beef demand.

levels were closer to 55 percent with concerns about fat consistently being slightly larger than for cholesterol. The correlation between the two health factors is apparent in Figure 11a.

Do these health concerns impact the buying habit for beef? The answer is yes and the statistical results are very strong in terms of confidence with the responses. In Figure 11b the left bars show the demand values while moving from left to right with strong concern about fats and cholesterol to no concern. The direction of change is what is important where, first, the likelihood of consuming beef increases from 71.2 percent to 76.7 percent as households show less concern about these health factors. Similarly, the servings per household member increase from 3.31 to 3.69 over the concern levels. Concern about these health variables negatively impact the demand for beef, that is clear. However, the levels of concern have declined somewhat over the years and that should be beneficial to the industry. That is, fewer households are in the far left column in Figure 11b. Also, there is no indication from the models that the impact of these health concerns have changed. More importantly for the beef industry, *the models with these cholesterol and fat type variables are not having an increasing negative effect on demand.*

Another health related factor more closely tied to the actual eating habits of consumers can also be used to show additional health factor effects on the demand for beef. Households expressed their attitudes about eating a range of fast foods such as pizza, luncheon meat, fried chicken, etc. They scored their willingness with a similar scale used above with one expressing the most willingness (or encouragement) to eating these type foods and six being the least willingness (or discourage eating). Like the fat and cholesterol type variables, the willingness to eat various types of fast foods were correlated and appropriate procedures were again used to deal with the data problem (see Appendix A). Figure 12 shows the substantial impact that eating attitudes have on the demand for beef. The probability of

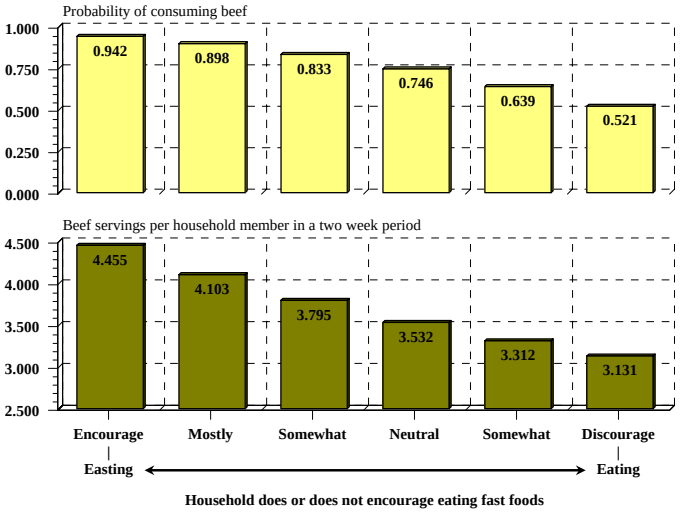

Figure 12. Degree of willingness to eat fast type foods.

consuming beef is over 90 among those encouraging eating the fast foods. Similarly, the servings per household member exceeds 4.4. The opposite response is seen among those households that discourage eating the fast food type of meals with the probability dropping to 52 percent and the servings to 3.13. The range of demand shifts over these eating practices are considerably greater than seen for cholesterol and fat effects. What Figure 12 truly illustrates is the *potential negative effects as consumers shift their diets away from the general fast food category, i.e. their preferences for certain types of foods.*

In terms of actual dieting, the households were asked if the head of the household was on a diet. Also, each household was asked to give a scaled response to concerns about calories and these variables were included in the servings models. Figure 13 provides the results from this health variable in terms of households who were proactive in terms of general restrictions on their food intake. As with the other figures the top graph shows the likelihood of consuming beef and the bottom figure gives the number of servings.

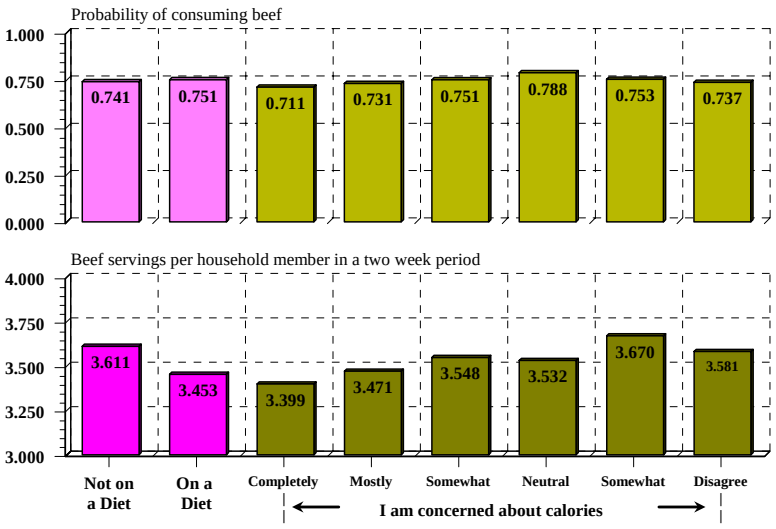

Figure 13. Impact of dieting on the demand for beef.

Probably the most interesting result from this health measure is *that the dieting has little impact on the whether or not you consume beef.* Similarly, the impact from the concerns about calories are mixed when deciding to or not to consume beef in the two-week period. Once a beef consumer, then the results are more pronounced. Beef serving decrease from 3.61 to 3.45 between those that are and are not on a diet. The number of servings per household member generally decline among those that are more concern about calories.

Figure 13 establishes that dieting and concerns about calories mostly impact the amount consumed and not as much impact on the likelihood of consuming. Dieting has much less impact on market penetration than on the quantity consumed.

(9.3) ***Behavior, Perceptions and Knowledge - Servings Model***

Households also make buying decisions depending on their perceptions and knowledge about the products being considered. Four variables were identified to capture these types of demand drivers thought to have some impact on beef demand: (a) You should eat *regular meals*; (b) I have more *knowledge about nutrition* that the average consumer; (c) It is important to eat *nutritious meals*; and (d) The *smell and look* of the product is important. Using Table 2, the probabilities and servings numbers are shown across the six point scale of agreement for each of these variables. Col. 1 shows the probabilities and servings when households score the importance of eating regular meals. While there are some inconsistencies with the market penetration numbers, for the most part eating regular meals has minimal impact on the likelihood of consuming or not. Most of the probabilities were in the mid-70's

Table 2. Impact of behavior, perceptions and knowledge on beef demand.

	Eating Regular Meals (Col.1)	More Nutrition Knowledge (Col.2)	Plan Nutritious Meal (Col. 3)	Looks & Smell Important (Col. 4)
Probabilities:				
1=Completely agree	0.783	0.653	0.793	0.764
2=Mostly agree	0.781	0.701	0.809	0.746
3=Somewhat agree	0.786	0.721	0.780	0.747
4=Neutral	0.581	0.807	0.728	0.733
5=Somewhat disagree	0.765	0.777	0.703	0.750
6=Completely disagree	0.752	0.794	0.639	0.731
Range in Probability (Between scale 1 & 6)	+3.1	-13.1	+15.4	+3.3
Servings:				
1=Completely agree	3.751	3.508	3.957	3.574
2=Mostly agree	3.621	3.483	3.824	3.541
3=Somewhat agree	3.612	3.546	3.686	3.530
4=Neutral	3.385	3.356	3.458	3.483
5=Somewhat disagree	3.528	3.610	3.251	3.495
6=Completely disagree	3.352	3.727	3.059	3.568
Range in Servings (Between scale 1 & 6)	+3.99	-2.15	+8.98	+0.06

levels. Whereas, when consumers indicated the importance of having regular meals, more beef was generally included in the diet. Compare the servings level of 3.75 with importance to 3.35 without the importance of eating regular meals.

Households also gave their subjective opinion about their nutrition knowledge relative to the average consumer. This is more subjective since each household must compare themself to all other potential and existing consumers. As a rule household use of beef declined in both the likelihood of consuming and the level of servings as the nutrition knowledge based increased. For example, the servings declined from 3.73 to 3.51 as the nutrition knowledge based increased and the market penetration shifted from .795 to .653. There is some paradox between Col. 1 and 2 in that beef use increases with regular meals but declines with nutritional

knowledge. Clearly, the concept of regular meals entails more than just nutrition. Even more perplexing are results with Col. 3 where consumers indicate the importance of eating nutritious meals. Both the servings and probabilities of using beef increase when consumers emphasize the importance of nutrition. This is just the opposite from the knowledge base results in Col. 2.

Finally, how important is physical appearance? Using smell and look as two indices of appearance, the models indicate *that looks and smell are of little consequence in influencing either or both market entry and level of use.* The range of change in both servings and the probability of consuming are very small and there is no consistent trend in either direction. Among the four factors in Table 2, planning nutritious meals has the largest overall impact and overall shows a positive impact on the demand for beef.

(10) Putting the Beef Checkoff in Perspective with other Demand Drivers

Several of the previous figures establish that beef demand differs depending on a range of demand drivers with many of these drivers closely tied to the demographics and attitudes of the decision makers. In Figure 14 these demand drivers are ranked in terms of the range of effect each can have, whether positive or negative. References back to Figure 1 again, the demand shift may be from (a) to (b) or (b) to (a) depending on the variable being considered. Also, movement from (a) to (c) encompasses the price effect over a reasonable range. Figure 14 is important primarily because it provides way of putting the beef checkoff in perspective relative to other things that influence consumers use of beef. Note that the ranges are shown without indicating whether the impact was positive or negative, rather the magnitude of the change is what is important. First and foremost, eating habits where households encourage eating types of fast foods (see Table 1) have a profound impact on the shifts in demand among the thousands of households included in the database. This is true for the market penetration and level of servings. The impacts drop off precipitously after the first three or four factors. An interesting demographic effect shows income to be a very important factor impacting the decision to buy beef but has a relatively smaller effect on servings. Whereas, aging impacts the decision to buy beef and has a relatively greater effect on the number of servings included in the diet over a two-week period. Also, dieting and the smell/look of beef, while statistically significant, show relatively low impacts on both the

probability and the level of beef servings. The interested reader can easily compare the relative values of other drivers of interest.

Based on the servings data, the demand for beef has definitely been influenced by the checkoff efforts as shown particularly with the marginal responses. However, when comparing the checkoff impacts in relative terms, they are quite small compared to the many other demand drivers incorporated into the servings models. Of the 17 factors included in Figure 14, the checkoff ranks 12 out of 17 when measuring the probability of buying beef and ranks 16 out of 17 when considering servings.

While the beef checkoff does shift demand, the relative rankings in Figure 14 shows why it is often difficult to visually see the impact since so many other factors can be changing over time and many of these other factors impact demand negatively. This also illustrates why one cannot analyze the beef promotion efforts in isolation of the other conditions that too could have some impact on food purchasing decisions. The bottom line conclusion using the beef servings approach is *that the beef checkoff has had a measurable and statistically significant impact on demand but the gains are small relative to other factors also influencing the buying decision.*

Two variables included in the servings model but given little attention are the other

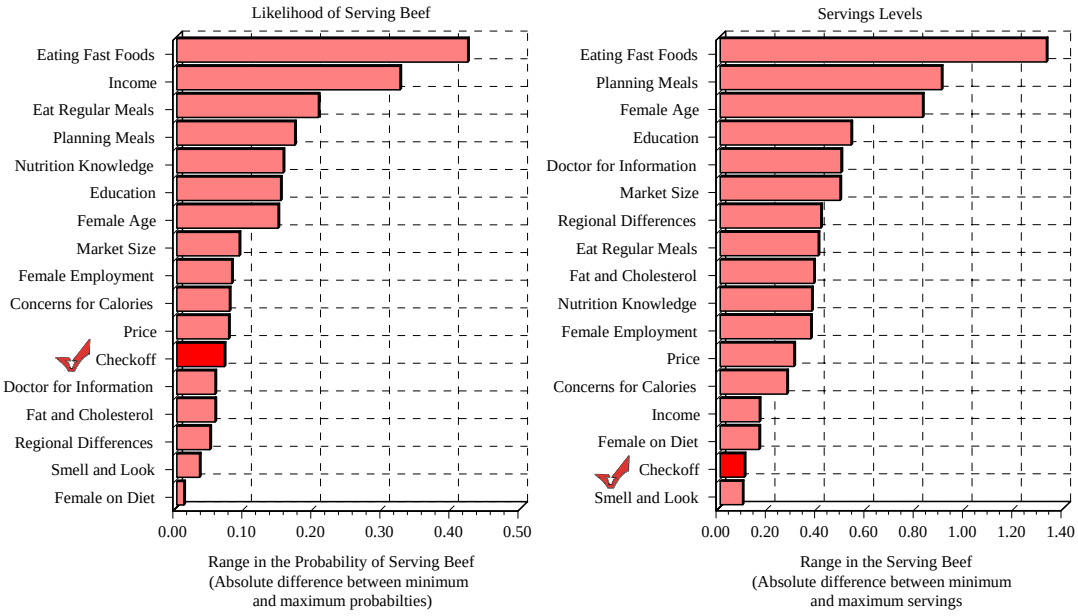

Figure 14. Ranking of the major demand drivers included in the beef servings model

prices of competing meats. In Appendix A the prices of poultry and pork were part of the servings estimates. Statistically, pork was not significant for the servings model and showed some small impact in the probability analysis. The poultry variable consistently had the wrong sign in the servings model. For the checkoff analysis, the inclusion or exclusion of poultry and pork prices does not change the conclusion that the beef checkoff has a positive and statistically significant impact on beef demand.

(11) An Alternative Approach to the Checkoff - A Time Series Model

All of the above analysis has been drawn on retail data for at-home consumption based on individual household responses. These data provide a richness in that one can distinguish those household characteristics and attitudes that are no longer available using more aggregated data. Since the conclusions about the beef checkoff up to this point are based solely on the servings data, it is desirable to pursue other data sources and attempt to measure the impact of the checkoff with an entirely independent set of data from the servings data. Also, with the servings data a number of conversion factors had to be used to move from the retail down to the liveweight level as was explained with equations (3) and (4).

A useful approach for comparison is to use aggregated market disappearance data commonly quoted and distributed by the beef industry (see the Livestock Marketing Information Center.) At this point in the market system all prices are quoted at the liveweight, boxed beef, and retail levels and pounds of beef are reported after slaughter. These data are aggregated across the country and reported quarterly. Total supplies are a combination of domestic production and imports. Within a given quarter one can make the assumption that supplies are fixed and, hence, cattle prices are some function of the these supplies and competing meat supplies along with other measurable demand drivers expressed in the aggregate. Accepting the premise that cattle prices are determined by the supplies in that same quarter, then a simple time series demand model can be estimated that shows the price/quantity relationship while also including the beef checkoff and other factors expressed in the aggregate. While this approach may not have the all theoretical rigor, the approach has been used extensively in promotion evaluation studies and has proven both practical and useful for drawing inferences about the beef checkoff. All technical details of the time series approach are laid out in Appendix B while the text will focus on the conclusions.

The concept is quite simple in that cattle prices within a given time frame depend on the market conditions at that time, including the available stocks. Prices rise or fall with changes in the beef stocks (i.e., movement along the demand curve) but the absolute price level depends on other demand factors given a specific stock level. Similar to the servings model, the challenge is to measure the impact of these other factors. While the full model has considerable detail, the major features includes (a) the relationship between cattle prices and beef supplies; (b) the effects of pork and poultry stocks; (c) income and a few other demographic trends; (d) a longer term measure for structural change through a time trend; (e) a health index based on concerns about fat and cholesterol; and (f) the dollar spent on the beef checkoff. All aspects of the model are presented in Appendix B. The estimates cover the quarters from 1987:1 through 2003:1. Since the primary interest is in comparing the impact of the beef checkoff with this approach, most of the discussion will focus on that aspect of the analysis.

(11.1) The Beef Checkoff and Cattle Prices

The complete time series approach to beef demand is discussed in Appendix B where the generic promotions are part of the model. Throughout the analysis, the beef checkoff is shown to have a positive impact on quarterly cattle prices and the estimates are statistically significant over the data period considered (see the t-values for the checkoff coefficients in Table B.2, Appendix B). Two applications of the time series approach are particularly useful. First, the marginal gains at the liveweight level can be compared with those derived from the servings model (see Figure 9) to see if the conclusions are similar from two independent approaches. Second, one can simulate changes in total cattle prices with and without the beef checkoff, thus deriving the total gains attributed to the beef checkoff at the liveweight level - the point of checkoff assessments.

(11.2) Marginal Rates and The Average Rate of Return

In Figure 15 marginal rates-of-return are shown over a wide range of annual checkoff assessment values using the market conditions for 2002. During that year total assessments were around $83 million and the distribution of funds were similar to those illustrated initially in Figure 3. For each incremental increase in assessments shown in the bottom axis of Figure 15, the corresponding gain in total industry revenues (net of the checkoff increment) are shown at the liveweight level. The bars in the fore front are based on the impact of the beef checkoff using the liveweight quarterly model and the vertical bars in the back are the equivalent liveweight marginal returns derived from the servings model. Several distinctions need to be emphasized again before comparing the results. First, the servings model is based on at-home data and, hence, excludes the away-from-home responses to the beef checkoff. Yet, when calculating the marginal gains the away-from-home share of the total beef demand was factored into the calculations (see equation (3), page 20). Then these gains from the servings model were expressed at the equivalent liveweight levels. In contrast, the liveweight model is already at the producer level and is aggregated over all uses of beef, including the away-from-home and at-home demand. Given this difference and the fact that the serving responses are based on individual behavior while the time series analysis is aggregated over

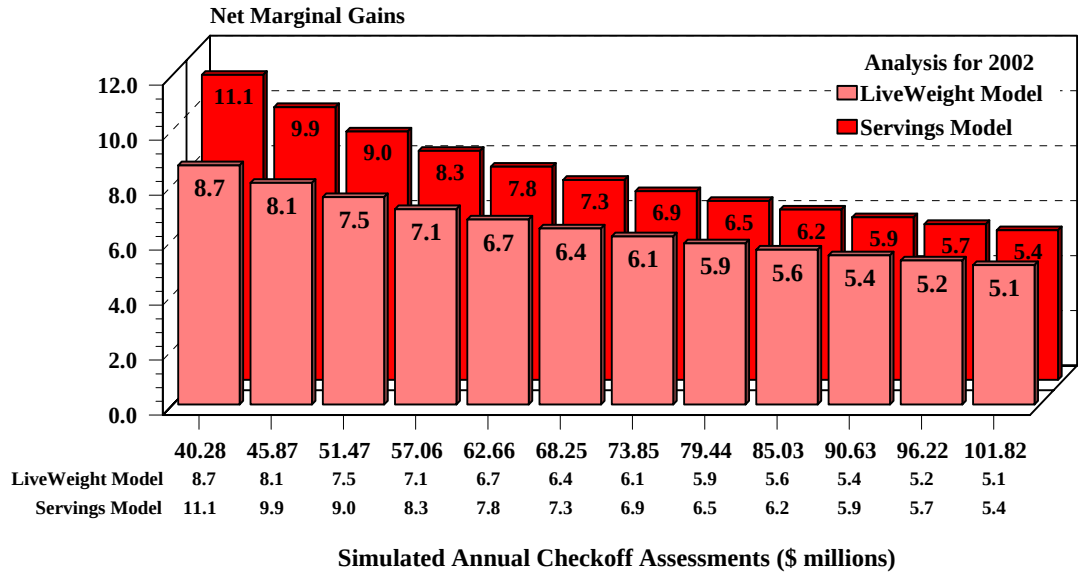

Figure 15. Marginal rates-of-return to the beef checkoff using the liveweight model and the serving model.

individuals, the marginal gains estimated from the beef checkoff would never be expected to be exactly the same with the two approaches. Yet, as seen in Figure 15 the marginal responses are very similar with these two independent approaches. Take the assessment level of $85 million for example, the marginal rate-of-return from the liveweight model is 5.6 and then 6.2 for the servings model. The pattern of decline in the marginal responses with these two independent ways of evaluating the checkoff are very similar throughout the range of assessments. Equally important, the marginal rates-of-return are still quite high for the upper range of assessments, thus indicating that the level of checkoff expenditures are not beyond the optimal point. Near the means level of assessments ranging between $79 to $85 million annually, the general conclusion is *that for each addition $1 spent on the beef checkoff the incremental gains in net revenues at the liveweight level are between 5.5 and 6.5, depending on which model is used.* Appendix A comments on exactly how the marginal effects were estimated. This conclusions is reinforced with two totally independent methods deriving the marginal gains. Also, the gains are consistent with what has generally been estimated in earlier analysis. As a final point, the marginal gains are not profits. Rather, they are the incremental increases in total industry revenues, net of the assessments, that can be attributed to the beef checkoff.

(11.3) Total Gains from the Beef Checkoff using the Liveweight Model

An advantage from calculating the marginal gains is that the starting value can be any reasonable level. Whereas, to calculate the total impact of the beef checkoff, the demand for beef must be determined with and without the generic demand enhancing efforts. There are two approaches to this measurement: (a) compare the total estimated demand with actual checkoff expenditures to the estimated demand assuming zero promotions; and (b) compare the total estimated demand with actual checkoff expenditures to the estimated demand assuming some underlying minimal level of promotions. The second approach seems more appropriate since the underlying premise is that there could have been some generic efforts even in the absence of the beef checkoff programs. In this case the estimated checkoff gains are relative to this base level. This approach gives more conservative estimated returns compared with using a zero base.

Figure 16 shows the estimated gains attributed to the beef checkoff using several

ranges in the base level of activities in the absence of the beef checkoff. For example, in the bottom chart in Figure 16, the bottom left value of 1 implies that there would have been at least one million per quarter in promotions even without the beef checkoff. Values to the right imply a higher base, all in terms of millions in expenditures without the checkoff. The time period includes 64 quarters starting with the second quarter of 1987.

First, to facilitate the discussion it is assumed that one million would have been spent in a typical quarter in the absence of the beef checkoff (i.e. the base = 1.0). Over the 64 quarters, an estimated $389.6 billion was spent on beef at the liveweight level. Since there are 64 quarters, that gives an average of about $6.2 billion per quarter in liveweight revenues or $24.8 billion annually. Given the total of $1.3 billion in assessments over the checkoff life, an estimated $9.02 billion addition dollars are a direct result of the checkoff (see the bottom left values in Figure 16). For comparison, if the base were instead set to $1.2 million per

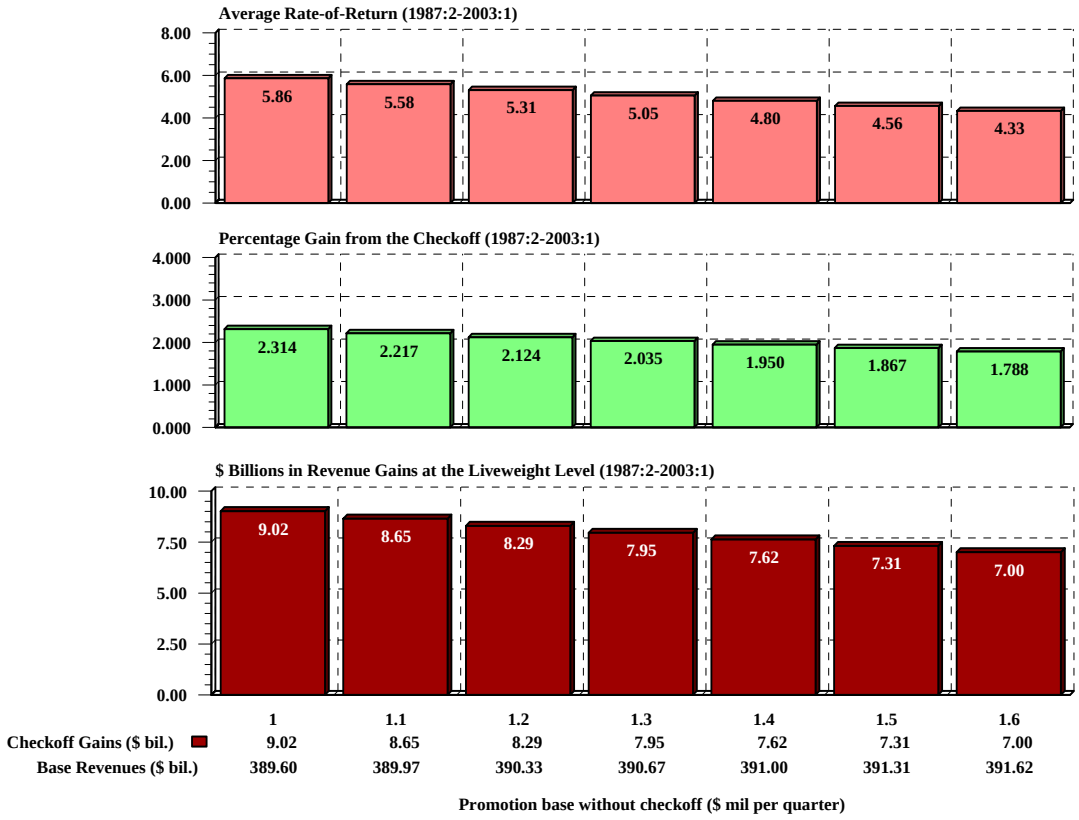

Figure 16. Estimated average rate-of-return to the beef checkoff using the liveweight model.

quarter the gains drop to $8.65 billion. All remaining estimates are easily seen in the bottom portion of Figure 16. Clearly the estimated gains drop off as the assumed base level without the beef checkoff is increased.

Using the upper portion of Figure 16, the resulting average rate-of-return is easily seen. For the base of $1 million, the rate is 5.86 and for $1.2 the rate decreases to 5.31. *Generally with the 1.0 to 1.3 base, the average rates-of-return are in the mid 5.0 range. These averages are very close to the marginal rates near the mean checkoff expenditure levels* shown in Figure 15. With these new models and updated data basis, we still keep seeing a rate-of-return somewhere in the range of 5.0 to 6.0. Even with considerable adjustments to a few underlying factors, the conclusion about the effectiveness of the beef checkoff is very robust.

While the upper and lower graphs in Figure 16 point to the positive gains from the beef checkoff, it is always prudent to puts these gains in perspective. The middle green bars in Figure 16 express the checkoff gains relative to the total returns over the study period. As seen, those gains resulting from the checkoff still account for only about 2.0 percent of the total revenues. While the beef checkoff is effective and has a relatively high rate-of-return, it is still a very small part of the total demand picture. Many other factors contribute to the revenues generated. While not comparable one-to-one, the small percentages in Figure 16 are consistent with the rankings of the beef checkoff presented in Figure 14 where other demand drivers where considerably more influential on demand than the beef checkoff.

(12) Conclusions and Inferences

Beef demand ultimately determines the economic state of the U.S. beef industry. The demand is driven by many factors having both positive and negative effects across households and over time and many of the changes in several demand drivers are beyond the control of the beef industry. Yet, some demand drivers such as the beef checkoff and the resulting generic promotions are directly controlled by the industry and government through the USDA. The beef checkoff has been actively used by the industry since 1987 with total assessments now exceeding $1.3 billion. Given that the checkoff is an industry/government controlled tool funded through a mandatory assessment, it is absolutely essential that the impact of the programs be known. Simply stated, is the beef checkoff having an economically meaningful impact on beef demand? To address this question two independent methods for measuring the

demand for beef were adopted with each including a measure of the relationship of the checkoff to demand. A beef servings model using at-home household data and an aggregate liveweight model were estimated and then used to derive a rate-of-return to the checkoff. In both models the checkoff was shown to have a statistically significant positive impact on the demand for beef. After accounting for the impacts of other demand drivers, the beef checkoff was used to derive the marginal rage-of-return and the average rate-of-return to the programs. The marginal returns were compared between the two methods for estimating beef demand. From these model several important conclusions immediately follow as highlighted in the points below:

- The demand for beef is positively impacted by the beef checkoff in terms of both influencing the demand to buy beef and the quantity of beef consumed by a household.

- While the checkoff impacts both the market penetration and number of servings, the market penetration plays the more important role. That is, the market penetration effect is greater than the changes in number of servings per household member.

- Over a reasonable range of promotion levels, the range of changes in market penetration lies between 72 to 79 percent of the households buying beef at some point in time. The servings range from 3.56 to 3.66 for the average household.

- Marginal rates-of-return from both the servings and the liveweight models are very similar over a wide range of simulated checkoff expenditure levels. This positive impact using two independent ways to estimate the marginal rates adds credibility to the conclusions about the checkoff.

- For the mean checkoff expenditure level, the marginal rates-of-return are in the vicinity of 5.5 to 6.5. That is, for each checkoff dollar, the total additional expenditures on beef increase by a factor of at least 5.5.

- While the marginal returns decline with more promotions, the returns indicate that the industry has not overspent up to this point in time.

- After estimating the effects of other demand factors, the models show that the relative impact of the checkoff is quite small compared with other demand drivers. The checkoff ranks 12 out of the 17 demand drivers when measuring market penetration and 16 out of 17 when considering servings. Other factors have more influence on the household demand for beef. Yet the checkoff is still effective when viewing the marginal rates-of-return and is the one demand driver where the industry has direct control.

- Using the liveweight model, the average rate-of-return was also estimated and shown to be in the 5.5 range. This average rate is very similar to the marginal rate near the means expenditures and very near the marginal rates from the servings model.

- From the liveweight model, the absolute gains relative to the total industry revenues are still quite small. Generally around 2 percent of the total industry revenues at the liveweight level is attributed to the checkoff. That is, the industry's total revenues are 2 percent greater with the checkoff.

Demand models as estimated in this report have several attributes that can be used for planning and market strategy purposes. Accepting the models with the demand drivers as specified, then what if types of questions can be asked? What if over time the checkoff were eliminated because of legal issues? What would be the impact? Equally, what would be the gains if the promotions were increased by some fixed amount? Suppose that external events such as BSE or other factors causing a negatively shift in demand occurred, could enough promotion dollars be spent to offset the decline from one or more of those events? While this report does not address these type issues, the model in place can be readily used to address these types of questions.

Secondly, these types of analyses have a scientific base using established statistical and economic tools. The numbers are estimated with known statistical properties and are not just guesses. Hence, they generally are useful for legal purposes when asked to draw inferences about the effectiveness of the programs. The fact that the results are quite similar with two independent approaches is very useful in these circumstances.

Third, demand is a concept that everyone understands in general but may not have the numbers immediately available. The sections showing the impacts of major demand drivers facilitate a more informed discussion of beef demand. This is particularly true when considering some of the health related factors.

Finally, long term marketing strategies should be designed with a full understanding of the impact of demographics and other related household attributes that influence beef demand. These type models can be useful to aid in developing target markets and audiences.

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Appendix A. Beef Servings Model

The beef servings model was based on a consumer panel diary with data collected over the quarterly from 1987:1 through 2003:1 with each household reporting for a particular defined wave (NPD). The waves can be closely aligned with corresponding months. Participating households were asked to record their servings of beef included in the household diet within a given two-week period. Households reporting no beef servings in the wave were included in the analysis, thus giving information about those using beef and then the level of use among households serving beef. All servings were expressed on a per household member basis in order to remove the effects of family size on the number of servings included in the total household diet. If beef was not served within the two-week period, that household was assumed to not be a consumer of beef for that period. This is important in that beef consumers will always consume at least some beef within the two-week period, i.e., there is no zero servings level for beef consumers. In turn, this leads to the classic double-hurdle model where first you must estimate the likelihood of consuming beef and after becoming a consumer, measure the level of servings. The first stage lead to calculating the probability of entering the market (i.e., market penetration) and the second stage shows the quantity served or intensity of beef consumption. Both buying events lead to the measurement of beef demand. These model variables for the complete data period are reported in Table A.1 with two types of models presented and explained below.

Theoretically, the likelihood and the number of servings could be easily influenced by the same factors and there is little argument to separate the factors affecting both decisions (Davidson and MacKinnon). Most of the variables entering the models were based on each household scaling their opinion or behavior to a specific question. In every case a six point Likert scale was used with one reflecting strong agreement or encouragement and six being the least agreement and strong discouragement. To be specific the following discrete variables were included in the servings models and level of scaling is noted. As seen in Table A.1 several of the variables are discrete measure taking up to 6 values, depending on the attributes of the variable. These variables are commonly expressed as dummy variables with the number of dummies defined according to the number of unique values in the original variable. One cannot include the full range of variables since by definition the sum of the dummies for a particular variable must equal one, thus giving the well known

dummy variable trap. One useful approach to this problem, and especially when there are so many variables as is the case here, is to restrict the sum of the coefficients to zero for a specific dummy variable group. For illustrate, suppose the variable Z takes six values and value four is the neutral scale and the coefficients associated with those dummies are δ_1 through δ_6. Then $\sum\delta_j=0$ where j=1,2,3...,6 and one of the coefficients can be expressed in terms of the others. While arbitrary, let $\delta_4 = -\delta_1 -\delta_2 -\delta_3 -\delta_5 -\delta_6$. In the original part of the model the variable Z enters the equation as $\sum\delta_j Z_j$, again j=1,2,..,6. With the restriction $\sum\delta_j(Z_j-Z_4)$ where j=1,2,3,5,6. This solves the dummy variable problem and the intercept in the full estimated model now reflects the average household if all dummies are treated the same way. Using this technique facilitates the general discussion since references can be to the average household instead using a specific set of dummies as the base and trying to keep track of all of the dummies in the base. This technique has been adopted for all of the estimates reported in Table A.2 and the restricted coefficient is clear from the notation.

Finally, the checkoff promotions are measured as the quarterly expenditures on advertising and programs of consumer and industry information. These dollars are expressed on a real dollars per million people basis. Note that the checkoff units are then expressed as a square root function, thus allowing the model to have the nonlinear response always seen with promotion type estimates. This approach has been used in many studies and has a real advantage for estimation purposes particularly when dealing with extremely small or zero promotion levels. While not reported, a range of alternatives to this nonlinear specification were considered and the results were quite robust. Also, a one quarter lag in the promotion efforts was incorporated into one of the models as another option. An underlying premise of the promotion variable at the national level is that it reflects the pattern of effort at both the national and state levels. State and national programs parallel, for the most part, and there should be a strong correlation between the two efforts. We do not know that precisely, however. Thus, the national dollars in the models should be also picking up the impacts of state generic efforts, to the extent they exists and occur at the same time. After the estimation, any uses of the models to calculate a rate-of-return should be based on the total effort and not just the national expenditures.

Finally, in Table A.2 the servings models have been estimated using the Heckman two-step procedure. Given the large number of observations with 31,181 in total and 25,529

when purchased within the waves and the number of variables in the model, this Heckman two-step procedure was adopted. In the second step, the model included the Inverse Mills ratio from the first stage and was also corrected for heteroscedasticity. The first stage non-lagged Heckman models are reported in the first two columns followed with the second stage for the same model. Then the same model with the lagged promotions added are reported in the remaining columns.

Except of the price and promotion all other variables were measured with the discrete codes reflected with the dummy variables. Hence, the intercept (C in Table A.2) is for the average household given a price and promotion value (i.e., see the discussion above about the dummies.) The t-values are reported to the right of each estimated coefficient and, given the large sample size, a reference table- t of 1.96 is appropriate for the 95 confidence level base (e.g., estimated coefficients with t>1.96 point to the impact of particular variables to be statistically different from zero.) Most of the text and focus of this report is on the beef checkoff impact and one can clearly see in Table A.2 the coefficients for the checkoff in the first and second stages are highly significant. That is, the checkoff has affected both the likelihood of buying beef and the number of servings, once a beef consumer.

Indices capturing health concerns and eating habits included several variables that were correlated. For example, concern about fat and cholesterol were correlated. Both the health and eating habit variables were weighted using principal component procedures to deal with the correlation problems. Note in Table A.2 health concerns are reflected with the health variables captured with PC1 and PC2 and the eating variables measured with BH1, BH2, and BH3. After estimating the coefficients it is a straight forward procedure to work back to the impacts of the original variables.

The estimation procedures are generally known, hence it is not necessary to include them here. It is, however, useful it illustrate how the models once estimated are useful. Consider Figure A.1 below. Using again Z above which could be any of the discrete variables in the estimated model, this variable must be scored as one and only one of the six values defined in Table A.1. Hence, the probability of all six scores must be 1.0 as illustrated in this figure with the cumulative normal distribution. Using the probit estimates (first stage) from Table A.2 for the average consumer, the probability for that average consumer is calculated. That is for the average consumer the likelihood of serving beef is a

given probability such as a value of .80. With this illustration, there is a 80 percent chance of including beef in the diet in a two-week period. Next the probabilities of each scale value from 1 to 6 is easily derived first estimating the cumulative values as shown and then taking the difference between the points. For example, the probability of a score of 4 is the difference between the cumulative for 4 and the cumulative for 3. With this procedure the impact of each scaled on the probability of consuming beef or market penetration can be measured and shown as presented in the text of the paper. Configuration of the cumulative normal depends on the estimates from Table A.2 and the assumption of the other variables in the model. Here, Z is compared to the average household but could easily be compared to sets of household characteristics.

The second stage impacts are similar to standard derivations once the household becomes a consumer. Using the second stage of the estimates in Table A.2 , the servings can be predicted for the average consumer across the Z scale or for any other variable in the model. This is precisely what was done in the text when illustrating the demand for beef among those consumers of beef.

In Table A.2 the two Heckman type models differ by the inclusion of a lagged promotion variable assuming a one quarter lag. The first model reflects the checkoff impact within the same quarter where any household reporting in waves corresponding to a particular quarter are exposed to the same checkoff promotions that took place in the quarter. There are obviously some implicit lags even within the same quarter since the waves differ within the quarter but the model does not differentiate among those waves since the promotion measures are not that time specific. Note in Table A.2 the inclusions or exclusion of the lagged checkoff has no impact on the other variables in the model. Furthermore, the lagged checkoff is insignificant in the first stage estimates (see the t-value of 1.21). However, in the second stage the lag is significant for the servings impact. One can use either model with the difference being the lagged effect. Since the matching of checkoff dollars and waves are not precise, the use of the lagged variable is considered with caution. Specifically, note the two second stage coefficients where in the non-lagged model the checkoff coefficient is 3.37 and in the second stage with lags the values are 3.24 and 2.29. Clearly the sum of the latter two values exceed that first model estimates. In the text one could determine the gains to the checkoff using either model and the lagged model is going

to give larger gains. To be conservative when estimating the checkoff gains, the more restrictive non-lag model is used. That is, we are assuring that the gains are no overstated by using the non-lagged model. What is most important is that with both models the checkoff is having a positive and statistically significant impact on the demand for beef.

The health and eating variables described in Table A.1 and included in the estimates in Table A.2 were measured asking the households a series of questions relating to eating and health. As might be expected the responses were correlated as shown in Table A.3 with the two correlation matrices. In Table A.2 the health effects were captured with PC1 and PC2 which correspond to the first two principal components from Table A.3. These components are derived by first standardizing the health variables and then weighting them by the first and second loading factors shown in Table A.3. Similarly, the eating behavior estimates were based on three principal components (BH1, BH2 and BH3) and these were derived by using the standardized eating variables weighted by the loading factors shown in the bottom portion of Table A.3. Using these statistics in Table A.3 and the estimates from Table A.2 one can work back to the original variable effects. These details are not shown since they are found in many econometrics text.

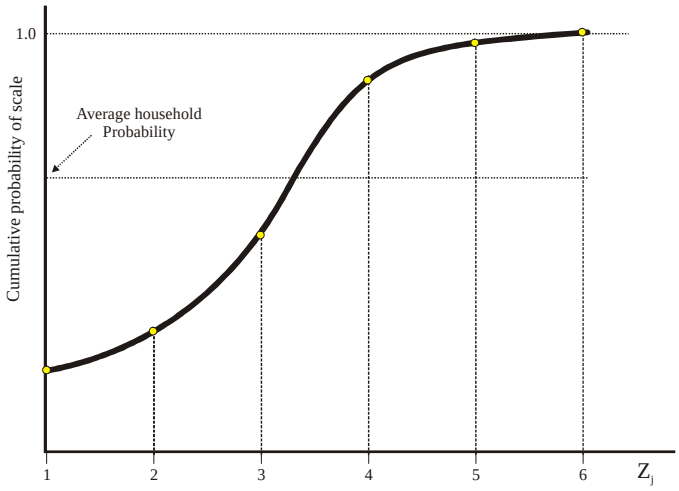

Figure A.1. Probability of serving beef.

Estimating the marginal rates of return are an essential part of the evaluation using both the servings and time series models as shown in Figure 15. The servings model included the impact of the checkoff on market penetration and level of servings. Hence, any marginal response to the checkoff should account for both effects and the results in Figure 15 include the total effect from the penetration and intensity measures. Specifically, the estimated marginal gains attributed to changes in the checkoff efforts accounted for the change in number of households buying beef and the change in number of servings per buying household. Hence, the marginal response reflects the full impact of the beef checkoff and not just servings or penetration

separately. Referencing back to equations (3) and (4) in the text, when estimating the marginal response both the servings per household member and the percent of households buying would change in accordance with the first and second stage models. Table A.4 shows the marginal responses for Figure 15 where both the market penetration and servings changes have been included when calculating the marginal gains.

Table A.1. Description of variables in the beef servings model.

Variable	Description	Units
ATDOC	Seek nutrition advice from doctor	Agree/Disagree scale 1-6
ATREG	Important to eat regular meals	Agree/Disagree scale 1-6
ATCAL	I am concerned about calories	Agree/Disagree scale 1-6
NTKNO	I know more about nutrition that average	Agree/Disagree scale 1-6
NTPLN	It is important to plan nutritious meals	Agree/Disagree scale 1-6
NTLOK	Look and smell of food in important	Agree/Disagree scale 1-6
DMMSZ	Market size (population size)	1=Mil+; 2=500/999; 3=50/249; 4=rural
NDMINC	Income range ($)	1=under $19,000; 2=$20/$40,000; 3=over $40,000
DMAGE	Age of female head (years)	1<35 yrs; 2=35/44; 3=45/54; 4=55/64; 5>64 yrs.
DMEDU	Education of female head	1=no HS; 2=HS; 3=some College; 4=Col. Grad
TDMFEM	Female is employed	1=Employed; 2=Not emp.
DTFEM	Female is on a diet	1= On Diet; 2=Not on diet
RPBF	Log(Nominal retail price of beef)	$ per pound
RPPL	Log(Nominal retail price of poultry)	$ per pound
RPPK	Log(Nominal retail price of pork)	$ per pound
NRMREG	U.S. Regions	1=New England; 2=Central; 3=South; 4=West
SQRTCHK	Sqrt(Real Checkoff $ per Mil pop.)	real $/mil. pop.
SQRTCHK-1	One quarter lag in checkoff	
NTFAT	A person should be cautious about fat	Agree/Disagree scale 1-6
NTCHL	A person should be cautious about	Agree/Disagree scale 1-6
NTADD	Cholesterol	Agree/Disagree scale 1-6
NTPRE	A person should be cautious about additives	Agree/Disagree scale 1-6
	A person should be cautious about preservatives	
FDHOT		Encourage/Discourage scale 1-6
FDPIZ	I encourage consumption of hot dogs	Encourage/Discourage scale 1-6
FDLUN	I encourage consumption of pizza	Encourage/Discourage scale 1-6
FDTAC	I encourage consumption of luncheon meat	Encourage/Discourage scale 1-6
FDFCH	I encourage consumption of tacos	Encourage/Discourage scale 1-6
	I encourage consumption of fried chicken	

Likert Agreement Scale: 1=Strongly agree; 2=Mostly Agree; 3=Somewhat Agree; 4=Neither; 5= Somewhat Disagree; 6= Strongly Disagree

Likert Encouragement Scale: 1=Strongly Encourage; 2=Mostly Encourage; 3=Somewhat Encourage; 4=Neither; 5= Somewhat Discourage; 6= Strongly Discourage

Table A.2. Heckman two-step beef servings model.

	Heckman Two-Stage Estimation with no Lag				Heckman Two-Stage Estimation with Lag			
1987:1-2003:1	**Probit Coef**	t-values	**Stage 2 Coef**	t-values	**Probit Coef**	t-values	**2nd Stage Coefficients**	t-values
C	4.62618	*6.97331*	14.32910	*10.29071*	4.54988	*6.83219*	14.22379	*10.23839*
PC1	0.01027	*0.95239*	0.04125	*1.95135*	0.01043	*0.96773*	0.04213	*1.99244*
PC2	0.03785	*4.40684*	0.08591	*4.54501*	0.03795	*4.41903*	0.08720	*4.61376*
BH1	-0.11590	*-9.74488*	-0.18115	*-5.11786*	-0.11575	*-9.73134*	-0.18449	*-5.22118*
BH2	-0.06427	*-7.37193*	-0.05572	*-2.43727*	-0.06431	*-7.37653*	-0.05770	*-2.52409*
BH3	0.02501	*2.90520*	0.08966	*5.24594*	0.02519	*2.92631*	0.09088	*5.31564*
ATDOC1	0.00739	*0.17164*	-0.08656	*-1.05703*	0.00735	*0.17050*	-0.08604	*-1.05048*
ATDOC2	0.00748	*0.17777*	-0.02859	*-0.38120*	0.00705	*0.16758*	-0.02838	*-0.37840*
ATDOC3	0.04884	*1.26780*	-0.04403	*-0.61259*	0.04903	*1.27276*	-0.04205	*-0.58486*
ATDOC5	-0.03037	*-0.71161*	-0.07707	*-0.93890*	-0.03003	*-0.70357*	-0.07606	*-0.92646*
ATDOC6	-0.10203	*-2.66009*	-0.19367	*-2.45313*	-0.10201	*-2.65961*	-0.19645	*-2.48939*
ATREG1	0.12270	*3.80332*	0.31027	*4.59492*	0.12258	*3.79962*	0.31430	*4.66153*
ATREG2	0.11518	*3.68174*	0.17454	*2.70340*	0.11532	*3.68592*	0.17846	*2.76756*
ATREG3	0.13255	*4.15597*	0.17819	*2.63406*	0.13230	*4.14799*	0.18134	*2.68520*
ATREG5	0.06450	*1.67640*	0.04467	*0.60876*	0.06441	*1.67411*	0.04576	*0.62378*
ATREG6	0.02090	*0.36072*	-0.16326	*-1.26809*	0.02031	*0.35057*	-0.16448	*-1.27778*
ATCAL1	-0.10342	*-2.66447*	-0.21534	*-2.81548*	-0.10353	*-2.66725*	-0.21977	*-2.87349*
ATCAL2	-0.04518	*-1.42982*	-0.09646	*-1.67361*	-0.04497	*-1.42321*	-0.09790	*-1.69920*
ATCAL3	0.01534	*0.54984*	0.02723	*0.53528*	0.01541	*0.55241*	0.02761	*0.54255*
ATCAL5	0.02292	*0.69311*	0.15538	*2.44455*	0.02340	*0.70735*	0.15743	*2.47504*
ATCAL6	-0.02702	*-0.72556*	0.02836	*0.39942*	-0.02634	*-0.70711*	0.02930	*0.41283*
NTKNO1	-0.26701	*-6.88981*	-0.24537	*-2.38393*	-0.26715	*-6.89342*	-0.25342	*-2.46038*
NTKNO2	-0.13198	*-4.36640*	-0.15408	*-2.39831*	-0.13213	*-4.37127*	-0.15867	*-2.46915*
NTKNO3	-0.07249	*-3.00199*	-0.04317	*-0.92373*	-0.07260	*-3.00668*	-0.04534	*-0.97010*
NTKNO5	0.10296	*3.20541*	0.15523	*2.53230*	0.10276	*3.19889*	0.15698	*2.56302*
NTKNO6	0.16137	*3.80657*	0.31398	*3.76493*	0.16134	*3.80622*	0.31928	*3.82736*
NTPLN1	0.15682	*5.51475*	0.54055	*8.05187*	0.15679	*5.51337*	0.54453	*8.11483*
NTPLN2	0.21679	*10.32842*	0.44853	*6.98305*	0.21681	*10.32906*	0.45468	*7.07969*
NTPLN3	0.11154	*6.07654*	0.23781	*5.46871*	0.11146	*6.07243*	0.24128	*5.54957*
NTPLN5	-0.12690	*-4.45359*	-0.38263	*-6.20069*	-0.12710	*-4.46064*	-0.38646	*-6.26039*
NTPLN6	-0.30466	*-7.26572*	-0.72863	*-6.39364*	-0.30454	*-7.26356*	-0.73724	*-6.47159*
NTLOK1	0.05860	*2.83773*	0.08691	*2.19932*	0.05889	*2.85149*	0.08997	*2.27722*
NTLOK2	0.00253	*0.12978*	0.01173	*0.31439*	0.00255	*0.13054*	0.01216	*0.32618*
NTLOK3	0.00499	*0.28082*	0.00252	*0.07701*	0.00494	*0.27796*	0.00308	*0.09435*
NTLOK5	0.01540	*0.74543*	-0.02529	*-0.67337*	0.01496	*0.72400*	-0.02568	*-0.68399*
NTLOK6	-0.04409	*-1.51963*	0.00164	*0.02840*	-0.04406	*-1.51849*	-0.00092	*-0.01591*

Continued on next page

Table A.2. Heckman two-step beef servings model - continued from pervious page.

	Heckman Two-Stage Estimation with no Lag				Heckman Two-Stage Estimation with Lag			
1987:1-2003:1	**Probit Coef**	t-values	**Stage 2 Coef**	t-values	**Probit Coef**	t-values	**Stage 2 Coef**	t-values
DMMSZ1	-0.14508	*-9.96794*	-0.33526	*-7.83399*	-0.14467	*-9.93658*	-0.33828	*-7.92902*
DMMSZ2	-0.09767	*-4.56933*	-0.29717	*-6.81346*	-0.09791	*-4.58028*	-0.30091	*-6.89563*
DMMSZ3	-0.00699	*-0.31760*	-0.02624	*-0.67459*	-0.00702	*-0.31871*	-0.02665	*-0.68542*
DMMSZ4	0.13638	*5.57218*	0.30770	*5.75910*	0.13633	*5.57027*	0.31177	*5.84226*
NDMINC2	0.17931	*7.95044*	0.25258	*4.18630*	0.17946	*7.95652*	0.25802	*4.27975*
NDMINC3	0.40025	*16.83114*	0.23286	*2.25839*	0.40062	*16.84446*	0.24640	*2.39087*
DMAGE2	0.14658	*8.40896*	0.42734	*9.59364*	0.14671	*8.41609*	0.43184	*9.69330*
DMAGE3	0.13208	*7.07319*	0.26375	*5.85222*	0.13218	*7.07824*	0.26814	*5.95320*
DMAGE4	-0.01318	*-0.68489*	-0.10034	*-2.91215*	-0.01350	*-0.70122*	-0.10155	*-2.94744*
DMAGE5	-0.29281	*-14.78863*	-0.74698	*-9.76579*	-0.29292	*-14.79379*	-0.75654	*-9.89414*
DMEDU2	0.14332	*8.64852*	0.25507	*6.05465*	0.14321	*8.64118*	0.25864	*6.14916*
DMEDU3	-0.03193	*-1.93235*	-0.07566	*-2.44227*	-0.03185	*-1.92748*	-0.07575	*-2.44576*
DMEDU4	-0.28345	*-16.94589*	-0.53642	*-7.42459*	-0.28356	*-16.95161*	-0.54514	*-7.54904*
TDMFEM2	-0.12406	*-12.21128*	-0.27938	*-8.54578*	-0.12386	*-12.19077*	-0.28240	*-8.65498*
DTFEM2	0.01582	*1.56786*	-0.06672	*-3.61720*	0.01590	*1.57557*	-0.06610	*-3.58284*
RPBF	-0.50795	*-2.94598*	-1.02267	*-3.02160*	-0.54663	*-3.11863*	-1.19054	*-3.43076*
RPPL	-0.49110	*-2.91240*	-1.01179	*-2.95165*	-0.47790	*-2.82635*	-0.97641	*-2.84667*
RPPK	0.18677	*1.09839*	-0.25418	*-0.77301*	0.22082	*1.28033*	-0.12879	*-0.38802*
NDMREG2	0.06332	*4.07086*	0.26809	*8.24489*	0.06315	*4.05933*	0.26920	*8.28178*
NDMREG3	-0.01530	*-1.11526*	-0.11023	*-4.39652*	-0.01517	*-1.10583*	-0.11016	*-4.39524*
NDMREG4	-0.06495	*-4.01204*	0.01778	*0.51155*	-0.06494	*-4.01112*	0.01609	*0.46299*
SQPTCHK	2.80842	*4.23772*	3.36954	*2.48805*	2.73016	*4.10257*	3.24484	*2.40340*
SQPTCHK(-1)					0.68070	*1.21085*	2.29528	*2.26067*
Inv. Mills			1.64187	*2.69849*			1.72266	*2.83456*

All models were estimated using TSP 4.5. (TSP).

Table A.3. Principal components for the health and eatings variables.

VARIABLES: NTFAT NTCHL NTADD NTPRE

Correlation Matrix

	NTFAT	NTCHL	NTADD	NTPRE
NTFAT	1.0000			
NTCHL	0.80735	1.0000		
NTADD	0.70042	0.68825	1.00000	
NTPRE	0.65400	0.62192	0.83944	1.0000

Component	Name	Eigenvalue	Cumulative R-Squared
1	PC1	3.1563941	0.78909854
2	PC2	0.49670225	0.91327410
3	PC3	0.19342957	0.96163149

Factor Loadings

	PC1	PC2	PC3
NTFAT	0.88962	0.32365	0.32033
NTCHL	0.87640	0.37816	-0.28674
NTADD	0.91000	-0.28807	-0.080825
NTPRE	0.87681	-0.40738	0.045475

VARIABLES: FDHOT FDPIZ FDLUN FDTAC FDFCH

Correlation Matrix

	FDHOT	FDPIZ	FDLUN	FDTAC	FDFCH
FDHOT	1.000				
FDPIZ	0.636	1.000			
FDLUN	0.734	0.666	1.000		
FDTAC	0.629	0.696	0.658	1.000	
FDFCH	0.703	0.649	0.707	0.691	1.000

Component	Name	Eigenvalue	Cumulative R-Squared
1	BH1	3.7087391	0.74174782
2	BH2	0.42700422	0.82714867
3	BH3	0.33004757	0.89315818
4	BH4	0.27202404	0.94756299
5	BH5	0.26218506	1.0000000

Factor Loadings

	BH1	BH2	BH3	BH4	BH5
FDHOT	0.8603	0.3504	0.1075	0.0640	0.3483
FDPIZ	0.8453	-0.3484	0.3514	-0.2004	0.0168
FDLUN	0.8758	0.2271	0.1356	0.1840	-0.3591
FDTAC	0.8522	-0.3472	-0.2546	0.2868	0.0773
FDFCH	0.8720	0.1032	-0.3342	-0.3340	-0.07485

Table A.4. Marginal responses using the beef servings model.

Average Price	Checkoff $mil	Servings Ser/2wk	Probability of Buying Percent	Net Marginal Gains
285.8100	3.3956	3.5007	0.7206	
285.8100	4.2445	3.5069	0.7258	11.0919
285.8100	5.0934	3.5126	0.7305	9.9208
285.8100	5.9423	3.5179	0.7347	9.0328
285.8100	6.7912	3.5229	0.7386	8.3294
285.8100	7.6401	3.5276	0.7423	7.7541
285.8100	8.4890	3.5321	0.7457	7.2723
285.8100	9.3380	3.5365	0.7489	6.8609
285.8100	10.1869	3.5407	0.7520	6.5044
285.8100	11.0358	3.5448	0.7549	6.1914
285.8100	11.8847	3.5488	0.7577	5.9138
285.8100	12.7336	3.5527	0.7604	5.6654
285.8100	13.5825	3.5564	0.7630	5.4413

Appendix B. Liveweight Demand Model

Liveweight cattle prices reflect the value of beef closest to the producer level and these prices are highly correlated throughout most of the reported markets. Hence, the prices in one of the major markets are generally a good indicator of the value of cattle, particularly when considering a quarterly average price. The Western Kansas liveweight price is consistently reported and provides a good indicator of the liveweight value Livestock Meat Information Center). Define this price as BFWKPR or the dollars per pound of liveweight equivalent beef as reported for Western Kansas. Unlike the household data with individuals, both the quarterly price and total stocks of beef are now aggregated for the quarter over all possible uses of beef. In the aggregate within a single quarter it is often argued that cattle prices are dependent on the stocks and other factors impact the aggregate demand for beef. Therefore, one approach to measuring demand is to estimate the models where price is now the dependent variable being expressed as a function of major factors expected to impact beef demand, including the potential impact of the beef checkoff. The role of the beef checkoff is explicitly defined to enhance the demand for meat for human consumption, not its byproducts. Liveweight beef value includes the byproduct value and that value has generally increased over time. In order to measure the checkoff impact, if it occurs, these byproduct value needs to be removed from the liveweight price. Let BFWPR2 be the real liveweight value after removing the byproduct value and correcting for inflation at the wholesale level. This price is then some function of a range of demand drivers somewhat similar to those expressed for the servings model as specified in equation B.1 below. The variables are defined following the equation.

$$\log(BFWPR2_t) = \hat{\beta}_0 + \hat{\beta}_1 \log(BFSTK_t) + \hat{\beta}_2 \log(PKSTX_t)$$
$$+ \hat{\beta}_3 PI_{1t} + \hat{\beta}_4 PI_{2t} + \hat{\beta}_5 TM_t + \hat{\beta}_6 TM_t^2 + \hat{\beta}_7 PZ_{1t} + \hat{\beta}_8 \sqrt{(CHK_t)} + \hat{u}_t \quad \text{(B.1)}$$

Existing stocks of beef influence the current cattle price where the beef stocks are defined as BFSTK=(BFPRD+BFBSTK+BFIMP-BFEXP-BFESTK)/POPUL with

BFPRD = millions pound of current slaughtered pounds of beef;
BFBSTK = beginning stocks of beef (millions lbs.);
BFIMP = imported pound of beef;
BFEXP = exported pounds of beef;
BFESTK = quarter ending stocks of beef (millions lbs.);
POPUL = U.S. population in millions of people.

BFSTK reflects the domestic disappearance of beef both at-home and away-from-home consumption in terms of pounds per capita. The pork (PKSTX) and poultry (PLSTX) variables are measured in a similar way. PI_1 and PI_2 are the first two principal components of the variables log(PLSTK), Log(DINC), log(PEREDU), and log(PERFEM) where:

PLSTK = millions of pounds of poultry per capita;
DINC = real per capita income ;
PEREDU = percent of the population having less than a High School education;
PERFEM = percent of females that are employed.

As show in Table B.1 there variables are correlated and, hence, it was not advisable to include each variable separately in the full model. Instead the variables were standardized and then weighted to give the principal components PI_1 and PI_2. These principal components capture the effects of each of there four variables in the model and are essential to a complete model even though interest in them is secondary to the promotion effects. Two health variables were also included in the model using principal components for the variables PRCHL and PRFAT where:

PRCHL = percent of the population expressing strong to moderate concern about cholesterol in the diet.

PRFAT = percent of the population expressing strong to moderate concern about fats in the diet.

In equation B.1, PZ_1 is the first principal component for these two variables. As with the P_{ij}, the focus of the aggregate model in the text is on the promotions so little use of the principal components will be made in the text. Even so, it is important to recognize that a health dimension has been incorporated into the aggregate model.

Beyond those variables noted above, often in aggregated data there are structural adjustments that are not fully reflected with the variables included in the model. For beef, there have been underlying changes attributed to a wide range of evens such as movement to white meats and the associated health concerns, new product development, changing life styles, etc. To account for the potential structural change, proxy time variables (TM and TM^2) in a nonlinear form have been included in the model. While not included in this report, even a Kalman filtering process was used to gain insight into the potential for structural change. Note if the coefficients β_5 and β_6 are both positive that would indicate continued growth in the beef demand throughout the study period. If the estimates are both negative, then beef demand declines rapidly. The expectation is that $\beta_5 < 0$ and $\beta_6 > 0$, indicating a potential decline but with signs of slowing the decline or even reversing it. As with the other variables, this process is assuring that the checkoff is not picking up some structural trend that is due to something else. Any conclusions about the checkoff could be understated but not overstated with the inclusion of this proxy trend variable. That is, the trend could be picking up some of the checkoff impact and, hence, lessening the impact suggested with β_8. The risk of not including the proxy trend is that someone could possibly argue that a checkoff coefficient is capturing structure change not attributed to the promotions. These arguments are academic if the checkoff expenditures have not trended in any way over time.

Table B.2 includes the estimated liveweight model for the full time period from

1987:1 through 2003:1. The coefficients and associated t-values are reported in Columns (1) and (2). Note that the price/quantity relationship is negative as must be and is statistically very significant as is the impact of the pork stocks on cattle prices. The trends carry (-) and (+) signs indicating a decline in beef demand over some period but with a lesser rate over the more recent periods. Note that the PI's are not statistically significant and the expectation is that the trends are probably picking up much of the effect of the variables included in the PI's. Finally, for evaluation purposes, the checkoff was lagged one quarter and the coefficient is positive and statistically significant. The model strongly indicates that the beef checkoff impacts demand and ultimately affects cattle prices. Unlike the household model, the checkoff efforts are lagged one period before inclusion in the model. This is expected given the aggregation and that the model is estimated at the liveweight market level.

As discussed in the text, the liveweight model provides a number of insights into the beef checkoff with two of particular interest to the evaluation. First, marginal rates of return to the beef checkoff can be estimated by simply ranging the checkoff expenditures in the model for a given time period. This gives the incremental change in liveweight cattle prices with each adjustment in the checkoff. Again, the marginal responses must be a specific time period since time is in the model. Secondly, the model is used to predict cattle prices over the life of the checkoff and the model explains 89 percent of the variation in these prices. Next using the same variable values for each quarter from 1987:1 through 2003:1, cattle prices are predicted assuming some base level of promotion expenditures as discussed in the text. Gains attributed to the beef checkoff are the differences between the cattle prices with ($\hat{P}$) and without ($\tilde{P}$) the checkoff. These gains are expressed relative to the total checkoff assessments in order to show an average rate-of-return to the generic promotion efforts. That

$$Gains = \sum_{t=1}^{77} (\hat{P}_t - \tilde{P}_t) Q_t - \sum_{t=1}^{77} CHK_t$$

$$ROI = Gains \div \sum_{t=1}^{77} CHK_t \qquad \text{(B.2)}$$

is:

The magnitude of the gains obviously depends on the checkoff coefficient and the base used to predict $\tilde{P}$.

Table B.1 Principal components for the liveweight models.

VARIABLES: LPLSTK LDINC LPEREDU LPERFEM

Correlation Matrix

	LPLSTK	LDINC	LPEREDU	LPERFEM
LPLSTK	1.00			
LDINC	0.916	1.00		
LPEREDU	-0.827	-0.763	1.000	
LPERFEM	0.762	0.668	-0.698	1.000

Component	Name	Eigenvalue	Cumulative R-Squared
1	PI1	3.3225636	0.83064089
2	PI2	0.36092332	0.92087172
3	PI3	0.24805040	0.98288432
4	PI4	0.68462725E-01	1.0000000

Factor Loadings

	PI1	PI2	PI3	PI4
LPLSTK	0.965	0.122	0.107	0.208
LDINC	0.922	0.280	0.222	-0.150
LPEREDU	-0.902	-0.0694	0.424	0.0340
LPERFEM	0.853	-0.513	0.0886	-0.0371

VARIABLES: LPRCHL LPRFAT

Correlation Matrix

	LPRCHL	LPRFAT
LPRCHL	1.000	
LPRFAT	0.887	1.000

Component	Name	Eigenvalue	Cumulative R-Squared
1	PZ1	1.8871745	0.94358727
2	PZ2	0.11282545	1.0000000

Factor Loadings

	PZ1	PZ2
LPRCHL	0.971	0.238
LPRFAT	0.971	-0.238

Table B.2. Estimates for the liveweight model.

Demand Drivers	Estimated Coefficients Col. (1)	t-values Col. (2)
Intercept	10.29046	10.13194
Beef stocks	-1.26599	-7.68808
Pork stocks	-0.35457	-3.44881
PI1	0.02620	1.06293
PI2	0.01005	1.49392
TM	-0.03440	-3.58671
TM2	0.00012246	3.06280
PZ1	0.03162	2.58995
Checkoff(-1)	0.03555	2.23574
	0	
Observation	77	
R2	0.89836	
DW	2.39213	
Rho	.7331	
Period	1984:1 to 2003:1	
Correction	1st Order AR1	