The Beef Checkoff Programs and Their Impact on U.S. Beef Demand

June15, 2009

Ronald W. Ward
Professor Emeritus
Food and Resource Economics Department
University of Florida
Gainesville, Florida 32611

Preface

Early in the history of the beef checkoff, the Cattlemen's Beef Board instituted a plan for evaluating the effectiveness of their programs. While effectiveness has many dimensions including administrative efficiency and message delivery, an important measure is the ability for the generic promotions to influence domestic and foreign demand for beef. All of the beef checkoff programs are ultimately intended to provide support to the demand side of the industry. Evaluating the impact of the programs is the focus of this study and entails using statistical models to estimate beef demand and the effects of the checkoff on that demand. Modeling demand is a technical process and those details are mostly left to the appendices of this report. The text concentrates on measuring the effects of major beef demand drivers, including the beef checkoff impact on demand. A final goal is to show the rate-of-return to the programs and its value to beef producers.

Estimating demand requires considerable data, statistical analyses, and interpretations. All of these steps were completed independent of the Beef Board and staff. The evaluation was funded by the Cattlemen's Beef Board under broad direction from the Evaluation Committee. However, the Committee had no input into the actual research or results. Rich Otley, Director of Evaluation of the Cattlemen's Beef Board, was instrumental in facilitating the evaluation process and his assistance with the administrative aspects of the project are acknowledged. John Lundeen and Greg Doud of the National Cattlemen's Beef Association (NCBA) were very helpful in securing the consumer data used in the evaluation. Peer review is an important part of research and we turned to two nationally recognized individuals to review the work. Dr. Oral Capps and Dr. Chuck Lambert are well-known economists completely versed in commodity promotions and the beef industry. Their input enriched the process and is truly appreciated.

Evaluations are dependent on the quality of consumer data available for empirical research. NCBA has a long history of buying consumer data from NPD (National Panel Diary) and the staff members were extremely helpful in updating the large consumer database used in the study. NPD staff Anne Mixen and Beth Pierce were essential to the process and their sensitivity to time constraints and data issues are greatly appreciated. The study draws on other databases and the help from Carlos Jauregui from the University of Florida is acknowledged. Technical writing is always a challenge and the editing assistance of Vera Sodek was invaluable. The final product is my responsibility and I certify that the work was done objectively without any preconditions or pressure from any groups. Any omissions are mine.

Table of Contents

Preface . . . . . page -1-

List of Figures . . . . . page -3-

List of Tables . . . . . page -4-

Executive Summary . . . . . page -5-

Introduction . . . . . page -6-

Overview of Beef Consumption and Value . . . . . page -7-

Insight into the Beef Checkoff . . . . . page -12-

Developing a Consumer Database . . . . . page -16-
- Household Demographics . . . . . page -18-
- Household Selected Attitudes and Behavior . . . . . page -19-

Estimating U.S. Beef Demand . . . . . page -20-
- Demand Model Specification . . . . . page -22-
- Beef Demand Model Estimates . . . . . page -23-
- Dealing with Correlation Problems . . . . . page -27-

Non-Promotion Demand Drivers . . . . . page -28-
- Eating Behavior . . . . . page -28-
- Household Attitudes and Concerns . . . . . page -29-
- Household Demographics . . . . . page -33-

Effectiveness of the Beef Checkoff . . . . . page -37-
- Checkoff Impacts Across Time . . . . . page -38-
- Market Penetration, Servings and the Beef Checkoff . . . . . page -40-
- Checkoff Impacts between 1987-2002 and 2003-2008 . . . . . page -42-
- Rate-of-Return to the Beef Checkoff . . . . . page -43-
- Checkoff Impact on a Liveweight Prices . . . . . page -46-
- Relative Checkoff Impacts from Entry versus Servings . . . . . page -48-

Conclusions and Implications . . . . . page -49-
References . . . . . page -55-
Appendices . . . . . page -57-

List of Figures

Figure 1. U.S. beef servings and frequency of buying beef. . . . . page -8-

Figure 2. Historical retail, boxed-beef and liveweight beef prices. . . . . page -10-

Figure 3. Quarterly average retail prices for beef, pork, poultry, and turkey. . . page -11-

Figure 4. Beef value expressed at the carcass-weight level. . . . . page -11-

Figure 5. Selected part of the Cattlemen's Beef Board website. . . . . page -13-

Figure 6. Checkoff expenditures in 1987-2002 compared with 2003-2008. . . . page -14-

Figure 7. Annual checkoff expenditures on promotions and information. . . . . page -15-

Figure 8. Theoretically deriving the demand for beef. . . . . page -21-

Figure 9. Impact on beef demand from the of encouraging and discouraging eating selected fast foods. . . . . page -31-

Figure 10. Impact of age on beef demand. . . . . page -33-

Figure 11. Impact of education on beef demand. . . . . page -34-

Figure 12. Impacts of employment and dieting. . . . . page -35-

Figure 13. Income impact on beef demand. . . . . page -35-

Figure 14. Beef demand across residency sizes. . . . . page -36-

Figure 15. Standardized beef checkoff coefficients over time. . . . . page -39-

Figure 16. The impact of the beef checkoff on market penetration. . . . . page -40-

Figure 17. Changes in beef servings attributed to the beef checkoff. . . . . page -41-

Figure 18. Simulated decline in beef demand attributed to reductions in the beef checkoff. . . . . page -44-

Figure 19. Estimated rate-of-return to the beef checkoff at the liveweight level. page -45-

Figure 20. Estimated changes in the liveweight and per head prices with incremental changes in the checkoff dollars (2003-2008 period) . . . . . page -47-

Figure 21.Relative importance of market penetration compared with the quantities of beef consumed. . . . . page -48-

List of Tables

Table 1. Distribution of household survey demographics. . . . . page -18-

Table 2. Distribution of household attitudes and behavior . . . . . .page -19-

Table 3. Market penetration model based on probit estimates. . . . . page -24-

Table 4. Beef servings model estimates using ordinary least squares. . . . . page -26-

Table 5. Estimated market penetration and beef servings across households' attitudes and health concerns. . . . . page -32-

Table 6. Average household response with and without the beef checkoff during a shopping occasion. . . . . page -42-

Executive Summary

The U.S. beef checkoff is an industry-funded program intended to provide beef producers with a marketing instrument for having a proactive role in the demand for beef, primarily through the use of generic promotions and consumer/industry information programs. Checkoff dollars are generated through a mandatory assessment of $1 each time a live bovine animal is sold. Legal authority for the beef checkoff, like most of the national generic promotion programs, is through the National Research and Promotion Act (AMS). Through 2008, nearly $1.8 billion in assessments have been used to fund the beef checkoff programs and state level checkoff programs. By law half of the assessments go to fund the national level programs, i.e., the Cattlemen's Beef Board. Since the industry has the authority to collect assessments there must be oversight to assure the programs are effective. This oversight is the responsibility of the Agricultural Marketing Service of the United States Department of Agriculture (AMS).

Has the generic promotion of beef had a measurable impact on beef demand? That is the most fundamental question for judging the effectiveness of the programs. To objectively determine the effectiveness, factors impacting the demand for beef must be determined including the effects of the beef promotions on that demand. Beef demand changes when a household decides to buy beef and then by how much beef is consumed. Generic promotions theoretically can both impact the likelihood of becoming a buyer and how much is consumed. Total demand is a product of the population base times the level of market penetration times the amount consumed per household member.

Beef demand models show the effects of a number of demand drivers including the beef promotions and household demographics. The checkoff is shown to influence the probability of becoming a beef consumer as well as the number of beef servings included in the household diet over a given time period. For the 2003-2008 period, 78.8% of the U.S. households purchased some beef in a two-week shopping period and the average household member included 3.42 servings of beef in their diet. Without the checkoff, market penetration would have been an estimated 3 percentage points less and .11 fewer servings per household member. Expressing these shifts in demand back to the liveweight level, the marginal rates-of-return to the program for the same period is estimated to be 5.55 for the average checkoff expenditure level. These marginal gains are substantially above one, thus pointing to a program that is quantitatively effective in influencing the U.S. demand for beef. Over the years since 2002, it has become increasingly more difficult to attract households to the market and more of the checkoff gains arise from increased servings contrasted with the percent buying beef. Yet, households buy beef and one seldom finds combinations of promotions and household demographics where the likelihood of buying beef falls below 70%. While beef demand changes with the level of promotions, other demand drivers have far greater impacts on demand. For example, beef demand drops dramatically with age of the household head. The study shows the impacts of other major beef demand drivers including the importance of nutrition and health concerns.

Program effectiveness has many dimensions extending beyond measurable shifts in beef demand. Administrative efficiency, creativeness, and fairness are all essential to a successful program and those aspects of the checkoff are not part of this evaluation.

Introduction

Demand is an economic concept used daily and almost everyone has some understanding of its meaning. It is an indicator of consumers' preferences for a product or group of products when faced with prices, limited resources, needs, and knowledge. Price is an index of the value placed on the product and limited resources place real restrictions on how much can be spent. Needs can be both essential and perceptional. Consumers select a food product such as beef to satisfy dietary needs but also for things such as convenience, variety, taste, habits, safety, packaging, health status, alternative foods, and the overall level of knowledge. Some food products are a core part of the diet while others are much less essential. Consumers most likely already have some reasonable level of understanding of the product attributes of the more staple food groups. Even demand for the staple food groups usually differs by consumer categories such as age, education or other demographics. Existing and potential consumers acquire knowledge about a product through experience and from both conscious and unconscious exposure to information about the food product. Exposure to store displays, television commercials, print media, package information, electronic media (website), and even sampling are just a few of the ways used to transfer information to the potential consumer.

Total demand is a product of the population base, the potential for attracting people to the product categories such as beef, and the volume once becoming a consumer of the food category. Since the population base differs demographically and geographically, demand likely differs with these population profiles. For example, one would logically expect the demand for beef to differ depending on a consumer's demographics such as age, education, income, region, family size, etc.

While the population is given at any point in time, the level of market penetration (becoming a consumer) and the consumption levels (quantity consumed) are subject to change. Efforts to influence demand through the transfer of knowledge and influencing perceptions can have differing effects on attracting new consumers to the food category (i.e., new beef consumers) compared with stimulating more consumption among existing consumers of the food product. Within the U.S. beef industry, the beef checkoff has been a primary instrument to both transfer knowledge and influence people to demand more beef. Impact of the checkoff on beef demand is an empirical question and the major focus of this report.

Measuring demand is a scientific process requiring the use of economic theory, statistical models, and data about actual consumer buying behavior. The theory sets guidelines for defining the demand structure, statistics and econometric methods give tools for empirical testing, and the data provide the base for exploring how the sampled population behaves. In the next several sections of this report, the goal is to provide broad insight into the current beef consumption patterns and then measure the effects of major beef demand drivers including the effects of the beef checkoff demand enhancing efforts. A primary purpose of the analysis is to determine empirically the economic impact of the beef checkoff on the U.S. demand for beef. This will include estimating the impact of the checkoff on market penetration or the probability of consuming beef within a defined period and the impact on the level of consumption among beef consumers. An end product is to determine the rate-of-return from beef producers' national checkoff assessments.

This report is divided into several sections starting with an overview of beef consumption trends. Next a history of checkoff expenditures is documented including details on specific utilization of the funds. A supporting consumer database is discussed in detail while showing the importance of having retail level data and information at the boxed-beef and liveweight levels. These data are then used to estimate the U.S. demand for beef using appropriate econometric models. Technical details of the models are presented in the appendices. Using the model results, the subsequent two sections show the impact of each measurable beef demand driver and then the impact of the beef checkoff on U.S. beef demand. The report concludes with a summary and major implications of the analyses.

Overview of Beef Consumption and Value

The U.S. beef industry is a complex agribusiness sector that has experienced structural changes, product innovations, and growing competition from other food sectors. Beef moves through the distribution system from live animals to retail and institutional outlets. Processing and distribution is highly technical and many of the details are beyond the scope of this analysis. Demand for the end product is, however, at the heart of the success of the beef industry and having a broader insight about consumption patterns is essential to measuring beef demand. To measure demand one must identify the appropriate point in the system and then determine the relative importance of factors expected to influence possible consumers. Likewise, any overview must have limits in terms of the time

horizon. Since the beef checkoff started its major programs in 1987, most of the following discussion starts with data points in the early 1980's and extends through 2008. Available data limit the scope of most demand studies and later in the discussion details about the retail at-home beef demand will be used as the major consumption behavior database.

As a starting point, Figure 1 establishes the basic consumer behavior pattern for beef consumption. In 1987, an average of 86% of the population indicated that households included beef in their diet in a two-week buying period. Clearly, most of the population consumed beef at some level. Among those buyers, the average household member included an average near 4.0 servings of beef in their diet for the same reporting period. The equivalence between servings and pounds is shown later to be approximately .40 pounds per serving. Through the rest of the 1980's both the level of market penetration and number of servings declined. During most of the 1990's, the average percent of households consuming beef within the two-week buying period fluctuated around the 80% level thus suggesting a dampening of the decline seen in the 1980's. For the same years, beef servings per household member dropped from more than 4.0 to closer to 3.5 servings as seen in Figure 1. Moving into the 21th century, market penetration ranged within the 70% to 80% levels depending on the specific periods and beef servings were in the levels of 3.0 to 3.5 (NPD).

While Figure 1 points to the general decline in market penetration, over the same period the U.S. population grew from around 242 million people to 305 million by the end of 2008. Using the 1987 market penetration average of 85% and 75% for 2008, an estimated 205 million people were buying beef in a two-week period in 1987 and a total of 228 million in 2008. Population growth has more than offset the decline in market penetration since 1987. Both the market penetration and serving levels reflect the population's use of beef

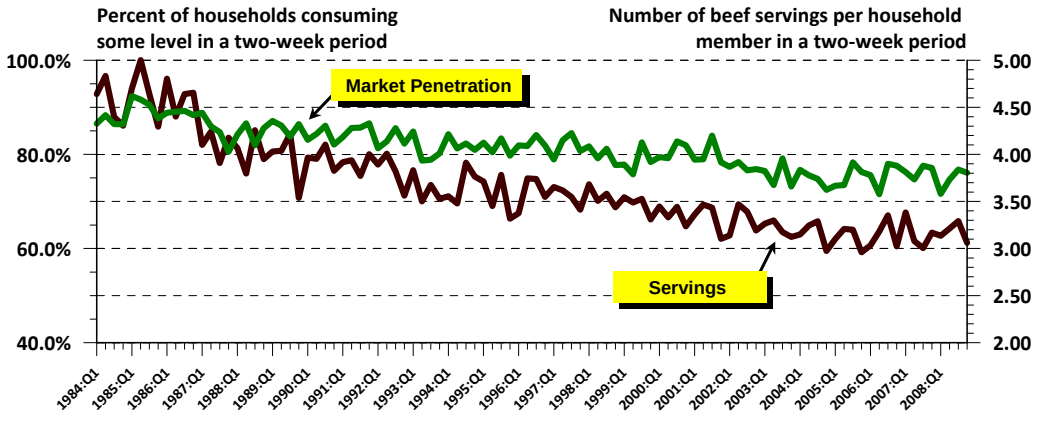


Figure 1. U.S. beef servings and frequency of buying beef.

and result from many conditions ranging from prices to changing demographics. Of primary interest is the role of the beef checkoff and how it has impacted the likelihood of buying beef and how much is consumed among those buying beef.

The combined effect of buyers entering the market and the frequency of serving beef in the household diet determines the quantity demanded. Yet, to fully understand demand, one must also know at what prices entry and consumption takes place. The story is entirely different if the numbers in Figure 1 occurred with retail beef prices near say $3.00 per pound compared with prices exceeding $4.00 per pound. Part of demand analysis is all about determining the relationship between consumption and prices and this relationship is referred to as moving along the demand curve. For a given price, market penetration and servings can change in a positive or negative direction depending on each demand driver value. These other drivers include things such as demographics, health concerns, eating behavior, nutritional consciousness, competing prices, location, and lifestyles. Such changes seen with a given price are shifts in demand and the direction and magnitude of a shift depends on the variable and its level. Theoretically and empirically, we have seen the demand for beef shift with the beef checkoff program. Measuring that shift, however large or small, must be estimated while accounting for other important demand drivers. Also, one must recognize that it is never possible to fully measure everything that influences beef demand and frequently a considerable amount of the demand shift is attributed to random behavior. Econometric modeling is the tool for separating the shifts in demand from movements along the demand curve.

Concurrent with the penetration and servings, Figure 2 shows the prices at which these consumer activities took place. While recognizing that beef is sold in many forms and packaging, an average retail price gives a good picture of the overall value at any point in time. Retail prices are shown to range from a low of around $2.30 per pound to highs approaching $4.50 per pound in the more recent years (LMIC). Much of the 1990's had prices in the $3.00 per pound range and then showed rapid increases starting with 2000. These rising prices are generally in the same years when penetration and servings were at historical lows, thus suggesting the price/quantity relationship or moving along a demand curve. Again this relationship will be shown empirically later in the report.

Figure 2 further shows beef prices at the boxed-beef and liveweight levels. As a general guideline, boxed-beef prices are approximately 38% of the retail beef price and liveweight prices are close to 24% of the retail. These percentage factors are good guidelines

since the correlation between retail and boxed-beef prices is .92 and the correlation between boxed-beef and liveweight prices is .96 (NASS-USDA). These price linkages are important since one can estimate changes at the retail and then use these percentage factors to express values at levels closer to the beef producers and points where the checkoff assessments take place.

The lower portion of Figure 2 does show some decline in the price linkages with the retail prices. In 1987 the boxed/retail relative prices were near 43% and by 2008 the relative value equaled 36%. Similarly, for the liveweight/retail the values equaled 28% compared with 22% in 2008. These linkages will differ from quarter-to-quarter but the general margins between retail and the lower pricing points have slightly increased over the years.

Beef demand should also be influenced by prices of competing meats including poultry, pork and possibly turkey. Figure 3 shows the quarterly average prices for each of the four meats starting with 1984. Beef has consistently been the most highly valued among the four meats with beef prices averaging 3.18 times that of poultry, 1.33 times pork, and 2.94 times turkey prices. Even with quarter-to-quarter changes in these relative prices, the correlations are quite strong with the beef/poultry correlation being .80; beef/pork correlation, .89; and a correlation of .70 for beef with turkey.

During the 2000's the price spread between beef and poultry has increased to 3.73,

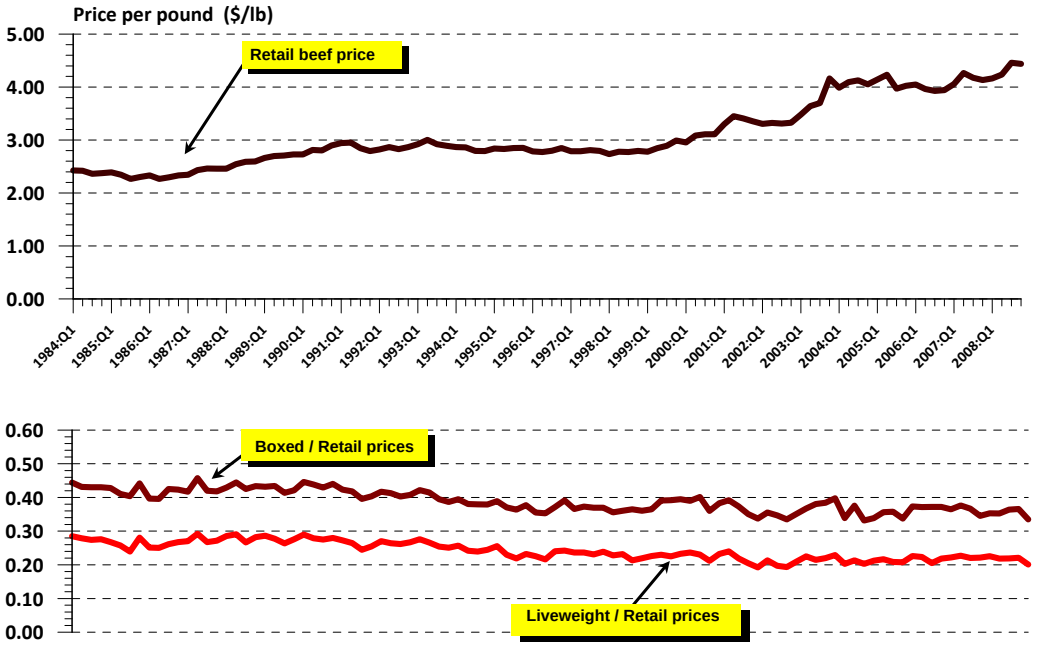


Figure 2. Historical retail, boxed-beef and liveweight beef prices.

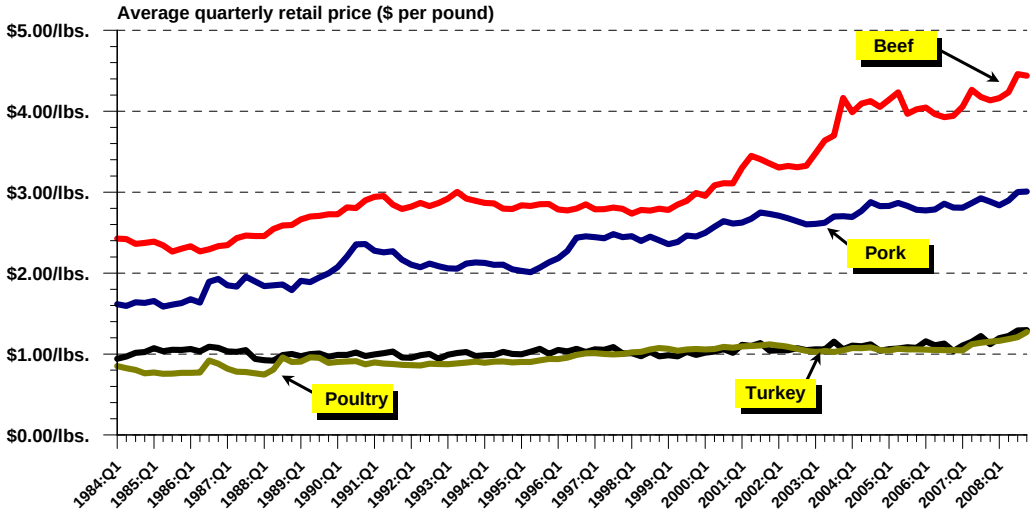


Figure 3. Quarterly average retail prices for beef, pork, poultry, and turkey.

again with quarterly variations. Similar values are seen for turkey. The spread between beef and pork has been more stable with the value since 2000 being around 1.44 compared to the overall average of 1.33. Later modeling will integrate these relative pricing values into the beef demand models.

Combining volumes with prices shows the overall value of beef at each point in the distribution system. In Figure 4 quarterly beef pounds at the carcass level are plotted along with the economic value using the carcass-equivalent price (see Figure 2). The most profound statistic is the substantial increase in overall economic value of beef starting around 2002. Carcass values ranged around $6.5 to $7.5 billion per quarter through most of the quarters up to 2002. Then in the subsequent quarters carcass values increased rapidly reaching near the $11 billion per quarter level by 2008. While demand depends on prices

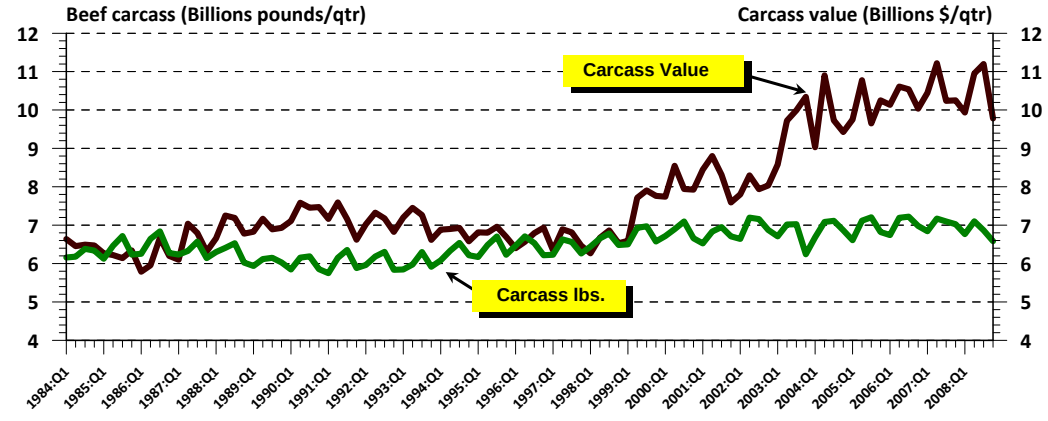


Figure 4. Beef value expressed at the carcass-weight level.

and all the other demand drivers, prices are also a reflection of the longer-term cattle supplies including imports. In much of the 2000's, cattle slaughters dropped to lows not seen since the early 1990's and those longer-term supplies contributed to the higher prices. The rapid rise in value compared to the quantities in Figure 4 is a function of the elasticity of demand and the price flexibility. An estimated price elasticity is shown after the demand models are quantified.

Figures 1-4 provide the foundation for measuring demand in that we know the level of market penetration, the household servings, and the corresponding prices. With information about the buyer demographics and attitudes and the promotional activities by the Cattlemen's Beef Board, the base is set for estimating the U.S. demand for beef.

Insight into the Beef Checkoff

In the early 1980's, initiatives for starting a national program for the generic promotion of beef were put into place. Since 1987, the programs have been active with major efforts to enhance the U.S. demand for beef and for expanding export markets for U.S. beef. Programs have evolved through time with themes such as "Beef, Its What's for Dinner" to major use of the Board's website to reach anyone interested in topics dealing with the use of beef. As illustrated with Figure 5, the latest website directs the reader to numerous sub-sites having detailed information on specific subjects. For example, from the Board's site *www.beefboard.com* one can immediately turn to the left portion of the page and link to promotion, research, consumer information, industry information, and foreign market programs. For promotions, the site *www.BeefItsWhatsforDinner.com* gives potential consumers insight into a wide range of beef tips, facts, nutrition information, recipes, contests, cookbook ordering information and the "Beef So Simple" newsletter. While media efforts such as the use of television have wide coverage, the website provides a means for an in-depth transfer of information to the inquiring visitor. Most of the demand-enhancing programs fall within four categories: promotions, consumer information, industry information, and foreign market development. Combining the first three generally entail the major domestic demand-enhancing programs (CBB; Beef Research and Information Act).

The beef checkoff is funded through a national checkoff where each time a live bovine animal is sold through normal commerce it is assessed one dollar. Usually this encompasses three transactions with calves, feeder cattle, and slaughter-weight cattle sales.

Figure 5. Selected part of the Cattlemen's Beef Board website.

By law, half of the assessments can remain with the state beef boards and half goes directly to the national Board. Over the years from 1987 through 2008, checkoff assessments totaled $1.795 billion for the 22-year period or averaging $81.6 million in assessments for each year. While the state/national allocations differ depending on if some of the state funds are given to the national level, on average the national funds account for 55.6% of the total dollars. For the 22 years, $998.6 million were used to fund the national checkoff programs. Our ultimate goal is to determine the economic impact of these funds. If over the years the exact same amount of funds had been used each quarter or other time units, it would be impossible to determine the economic impact. Fortunately, that is not the case as evident by a coefficient of variation in the quarterly expenditures of 25 or a standard deviation relative to the mean. A value of zero would indicate no variation in the variable and that clearly is not the case. This is a first test of the feasibility of measuring the impact of the beef checkoff (Cattlemen's Beef Promotion and Research Board).

Figure 6 provides more details on the expenditures from the checkoff funds. For the total of $998.6 million, 72% or $ 715.7 million was spent during 1987 through 2002 and 28% from 2003 forward. This is noted because later models will consider the checkoff impacts for these two time spans.

Promotions along with consumer and industry information accounted for 76% of the Boards' programs over the 1987 though 2002 years. The remaining 24% included foreign

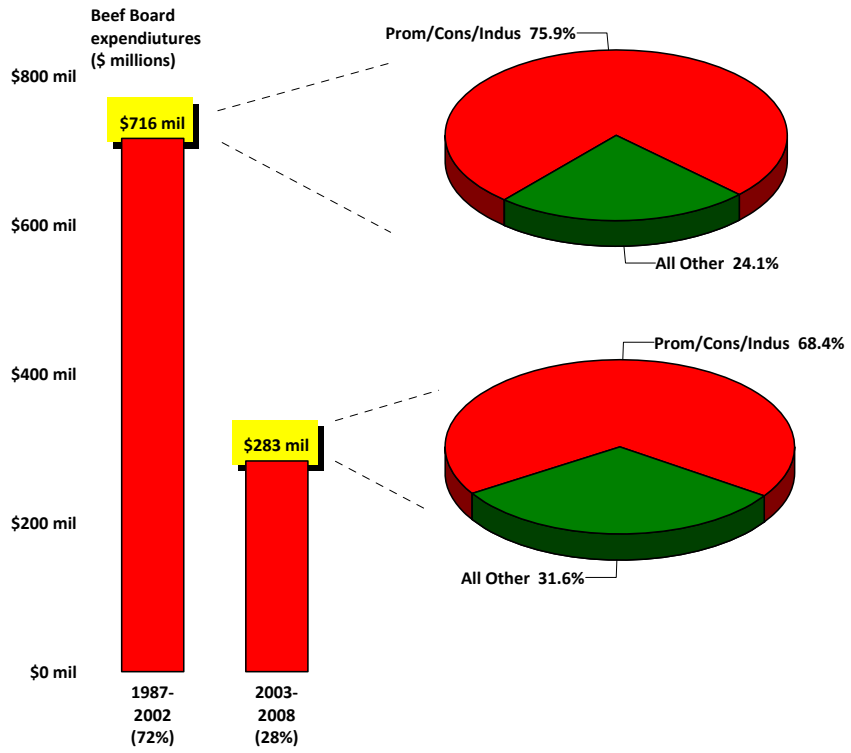


Figure 6. Checkoff expenditures in 1987-2002 compared with 2003-2008.

promotions, oversight, producer communications, research, and administrative costs. Since the promotions and consumer/industry information are most directly related to immediate demand enhancement efforts, it is those dollars that are included in the demand models. From 2003 to 2009, the promotions and information programs captured 68.4% of the total Board budget for an approximate 8% lower expenditure emphasis on the most direct demand enhancing programs. A substantial part of the difference in these more recent years is found with the Board's increased investment in consumer product research where the research percentages increased from 8.4% to 13.5% between the two periods. Likewise, the percentages for direct communication with producers increased from 8.2% to 9.4% of the total budget for the same two periods. What is not seen within the statistics are any changes in media use, message, and consumer targeting (CBB).

Finally, Figure 7 shows the variation in the promotion and other demand enhancing efforts. Direct promotions historically account for 77% of these efforts while consumer and industry information are around 15% and 7%. While the models will consider the combined impact of these programs, part of any change in the effect of the programs over time may be

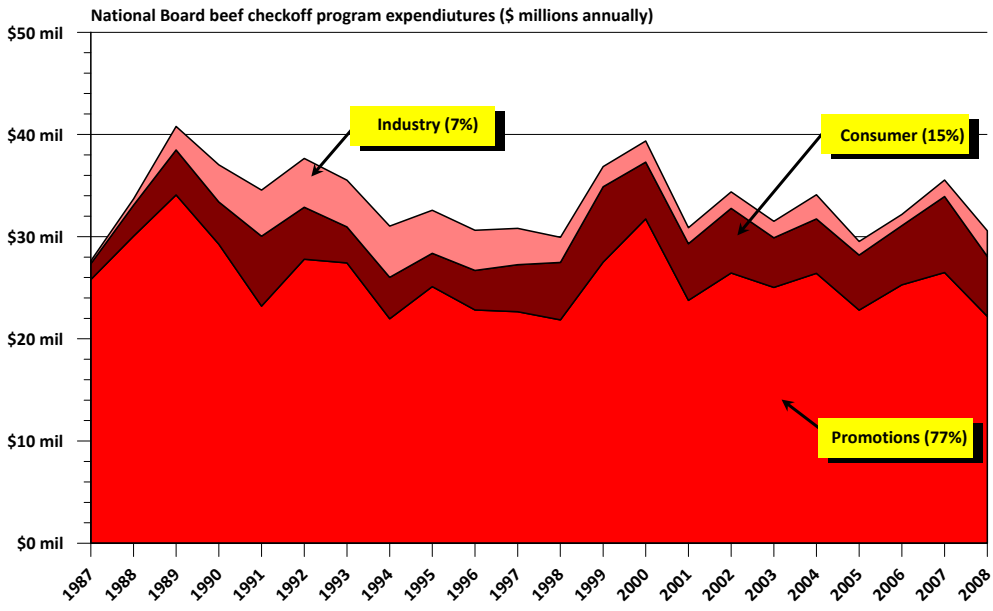


Figure 7. Annual checkoff expenditures on promotions and information.

partially due to how the expenditures are allocated among the three emphasis areas. As seen in Figure 7, industry information share of the total declined in the 2003-2008 period.

All dollars in Figure 7 reflect the national expenditures for immediate demand enhancing programs that do not include state level expenditures. State checkoff expenditure data are not available and, to accommodate the evaluation, an explicit assumption is adopted that the state expenditure patterns generally follow those of the national programs. This is reasonable since the state leaders are involved on the Cattlemen's Beef Board and the states have ready access to the materials developed at the national level. For some programs, the states have used the same advertising agency. One can view the promotion and information expenditures as an index of the total checkoff expenditures.

Developing a Consumer Database

Viability of any food sector ultimately depends on the populations' use of the food. Buying behavior depends on demographics, attitudes, experiences, health situations, and knowledge. In order to estimate demand, one must have data on the pool of potential consumers of the products under study. There are several approaches to gain information about potential consumers with each having strengths and weaknesses. In one extreme,

focus groups can be used to gain some insight into a small sample impression of a narrow set of issues on food attributes. While useful, such data give very little insight into actual consumption behavior. On the other side of the spectrum, data aggregated at market distribution levels provide considerable information about the product use and flow to the market. By definition, aggregation limits the data about consumers since much of the aggregation is across broad demographics and other characteristics. A third and expensive approach is to collect information directly from a sample of the population. If done properly, such data are collected across the population and over extended periods of time. It should include people who do and do not consume the food of interest, in our case beef. This data type is usually the most expensive and requires long-term planning to make sure the information is collected scientifically and consistently over time. Commodity boards frequently turn to private data collection companies for consumer-specific databases and that is the situation for the Cattlemen's Beef Board and the National Cattlemen's Beef Association (NCBA). For many years, NCBA has maintained a contract with an international data collection company to assure continuity in a database about potential consumers of beef. That database is the foundation of this statistical analysis of U.S. beef demand and the impact of the beef checkoff (NPD, 2009). In the remaining discussion these data will be referred to as the "servings data."

NPD's meat servings database is unique in that it extends back to 1984 up to February 2009 with the information consistently recorded over two-week shopping periods. These reporting periods are defined as waves (a two-week buying time) where households report their consumption activities within that wave. A wave can be directly tied to a month and year. Some households may report for many waves and others remain in the sample for shorter periods. In every case, the profile of the household is known, however long the household remains in the sample. For the years from 1984 through 2008, the NPD household database has 48,144 observations covering demographics parallel with the U.S. census.

Beyond the extensive time and demographic coverage, this rich database includes households who did and did not buy beef within a given wave. Thus, one can immediately determine the level of market penetration (see Figure 1) and the level of consumption among those households indicating some level of beef purchases in the two-week period. Since beef in some form is consumed throughout the year and is generally considered part of the at-home and away-from-home menu, it is reasonable to study the level of market penetration

within a wave (i.e., two-week buying period). For more seasonal goods one might consider a longer period to determine the level of market penetration.

The database includes four categories of information essential to measuring beef demand where households answer a series of questions (see Appendix A for the full questionnaire):

(1). *Beef consumption* - Did you purchase beef within the assigned reporting wave and if so, how many servings of beef did you include in your household in the two-week period?

(2). *Household demographics* - What is the female household-head age, education, household income, martial status, household size, location, number of children, resident city size, and employment status? A shortcoming of the data is that it does not include race (see Table 1).

(3). *Household behavior* - Do you encourage the consumption of certain foods? Are you on a diet and do you exercise regularly? What is your nutrition knowledge level and do you practice serving nutritional meals? Do you seek nutrition advice from your doctor and would you like to lose weight? These are a few of the behavior measures from the full questionnaire.

(4). *Household concerns* - Are you concern about fats, cholesterol, preservatives, and additives? Are you concern about being overweight? How important are smell, taste and looks of the food consumed? Again, Appendix A has a more extensive documentation of the questions.

Since the database includes individuals who did not consume beef, it is not possible to directly know the prices faced by potential buyers. Those reporting were not asked about the prices. A shortcoming of the database is that we do not know directly anything about beef prices from the data. However, retail beef prices are readily available for aggregate market clearing data (LMIC) and those prices can be matched with the household panel waves to provide an average retail beef price for each period. Time-series prices were merged with the 48,144 household reports using the assumption that the average beef price for any given month is a good barometer of the retail value of beef that a household faced during the appropriate waves (NPD).

In a similar way, it is impossible to know exactly how much information and sources that a household was exposed to. Adopting the same method used for prices, the checkoff

Table 1. Distribution of household survey demographics.

Variable	Percent	Variable	Percent
Household Size		Market Size	
1 Member	23.3	One million plus	43.6
2 Members	33.2	500,000 to 1,000,000	11.5
3-4 Members	32.9	250,000 to 499,999	11.1
5+ Members	10.6	10,000 to 249,999	11.1
		Rural/non-metro	22.6
Female Head Age		Female Education	
35 years and under	24.3	No High School	6.3
35-44 years	22.3	High School	31.1
45-54 years	19.1	Some College	26.5
55-64 years	16.5	College Graduate	36.1
65+ years	17.8		
Household Income		Residency Region	
less than $40,000	59.3	North East	20.6
$40,000 to $69,999	25.8	Central	25.3
$70,000 or more	14.8	South	34.7
		West	19.4

efforts were merged with the household data. For both prices and promotions we turn to the time-series data as the source and match both with the household reporting waves

Household Demographics

Table 1 presents the basic household demographics with the characteristics expressed as percent of the sample population for each demographic. For example, 17.8% of the survey household female heads are over 65 years of age. Similarly, 43.6% of the respondents live in cities over 1,000,000 in population. Almost 60% of the households have incomes under $40,000 per year. All of the sample distributions generally parallel national census statistics. The table is self explanatory so no further discussion is needed except to note that these household characteristics will be incorporated into the beef demand models.

Household Selected Attitudes and Behavior

Table 2 shows several attitudes and behavior characteristics of the households included in the beef-servings data set. Each household was presented with these questions and then asked to express their degree of agreement or disagreement using a six-point scale

of agreement/disagreement (or encouraging/discouraging) as outlined in Appendix A. This scaling is based on the widely used Likert scoring and is readily adaptable to empirical research and demand modeling. All percentages are averages over the full sample and, clearly, the scoring will differ from household to household. A quick view of the averages points to considerable differences in the scoring across the variables except for issues related to concerns about health variables. The percentages for concerns about fat, cholesterol, additives, and preservatives follow similar patterns from the agreement to disagreement scores. A more in-depth analysis shows these four health variable scores to be correlated and issues related to these correlations must be dealt with in the demand modeling. This is a

Table 2. Distribution of household attitudes and behavior.

1=Completely Agree 2=Mostly Agree 3=Somewhat Agree 4=Neither Agree or Disagree 5=Somewhat Disagree 6=Mostly Disagree	(1) Avg. %	(2) Avg. %	(3) Avg. %	(4) Avg. %	(5) Avg. %	(6) Avg. %
Doctors gives advice on diet	10.2	9.8	16.6	30.1	8.6	24.7
It is importance to eat regular meals . . .	26.7	24.3	20.4	17.6	8.5	2.4
I am conscious of calories	9.5	17.4	26.3	24.9	12.6	9.3
Know more about nutrition	6.8	13.1	25.1	36.7	11.6	6.7
I plan nutritious meals	11.8	23.4	29.5	23.9	7.8	3.6
Most important food looks, smells, tastes good	17.2	17.7	22.7	21.5	14.4	6.4
Should Be Cautious About - Fats	35.8	23.5	20.4	16.9	2.1	1.3
" - Cholesterol . .	33.4	23.0	22.3	18.0	2.1	1.2
" - Preservatives	26.4	21.3	22.5	25.0	3.1	1.6
" - Additives	29.5	21.1	22.5	22.9	2.5	1.5
I encourage eating - Hot dogs	2.4	3.4	15.7	50.0	15.5	13.1
" - Pizza	8.0	10.8	21.7	48.5	7.6	3.3
" - Lunchmeat	4.8	7.6	17.7	44.5	14.9	10.4
" - Taco	5.4	8.4	18.2	51.9	8.5	7.6
" - Fried chicken . . .	4.3	5.4	14.9	41.8	18.7	14.9
Female head on a diet (Yes=1, No=2)	28.3	71.7	-	-	-	-
Female head employed (Yes=1, No=2)	54.0	46.0	-	-	-	-

well-known statistical data problem that will be discussed in the appendices to the report.

Tables 1 and 2 give a summary of the household database providing the foundation for empirically determining the U.S. demand for beef. It is rich in content and a large sample well representative of the U.S. population demographics. Most important, the data provide precise numbers for deriving both market penetration and levels of consumption (i.e., both buying beef and serving beef in the diet). To repeat, we have more than 40,000 observations recorded over time since 1984 and across the full spectrum of the U.S. population.

Estimating U.S. Beef Demand

To set the stage, assume that we have a beef demand driver "v" that has a positive impact on both the probability of buying beef and the number of servings of beef in the household diet. (Note the example could as easily been shown for a negative impact.) Figure 8 can be used to illustrate both the model and empirical requirements to estimate beef demand. At a point in time there is a given population that is independent of the activities of the beef industry. How much of the population consumes beef during the defined period can possibly be influenced by the beef industry if promotions work, food is safe or unsafe, and the products are consistent with consumer preferences. In panel (A) a relationship is suggested where a demand driver "v" impacts the likelihood of buying beef. To illustrate, "v" could be income assuming that raising incomes lead to more of the population buying beef. Alternatively, if "v" had no impact on market penetration the response in panel (A) would be perfectly flat. Changes in "v" produce shifts in beef demand for a given beef price and other variables set to predetermined levels. The first empirical challenge then is to estimate the response in (A) for each demand driver expected to influence the chances of buying beef. Next, panel (B) depicts a positive response in beef servings to changes in the same variable. This rise in beef servings is among those individuals who became beef consumers. Panels (A) and (B) are typical of what is often called the double-hurdle model. First, what causes one to become a consumer (first hurdle) must be estimated then among those buyers the second hurdle determines the consumption levels or servings per household member (Long; Davidson and MacKinnon).

Note in Figure 8 one would generally expect the same direction of effect of a variable on both market penetration and servings. The magnitude of the impact would most likely differ and even possibly having no impact on panel (A) while impacting (B) (or vice

versa). Under some conditions one might even visualize the direction of effects differing between (A) and (B). Turning to the statistical modeling is the way to quantify both relationships.

Finally, panel (C) is a product of the Pop × Penetration × Serving per capita = Total Servings. For the checkoff evaluation, the issue is to determine statistically any response between checkoff dollars and the level of market penetration and servings. Econometric models provide the empirical methods. These models provide the empirical values corresponding to the curves in Figure 8 and results for stating the level of statistical confidence one can have with the responses. Again for the checkoff example, the model shows the response to the beef promotions and the level of statistical confidence that can be placed on the results.

Demand Model Specification

Market penetration as suggested with panel (A) in Figure 8 is a classic binary measure where each household indicates if beef was or was not purchased during the assigned reporting periods (waves). Let D be the market penetration variable taking a value of 1 if beef was purchased and zero otherwise. D should be impacted by identified demand drivers including the effects of the beef checkoff expenditures (i.e., market penetration is a function of all of those variables expected to influence the likelihood of buying beef). Equation (1) provides the structure of the market penetration model expressed as functions of the measurable demand drivers:

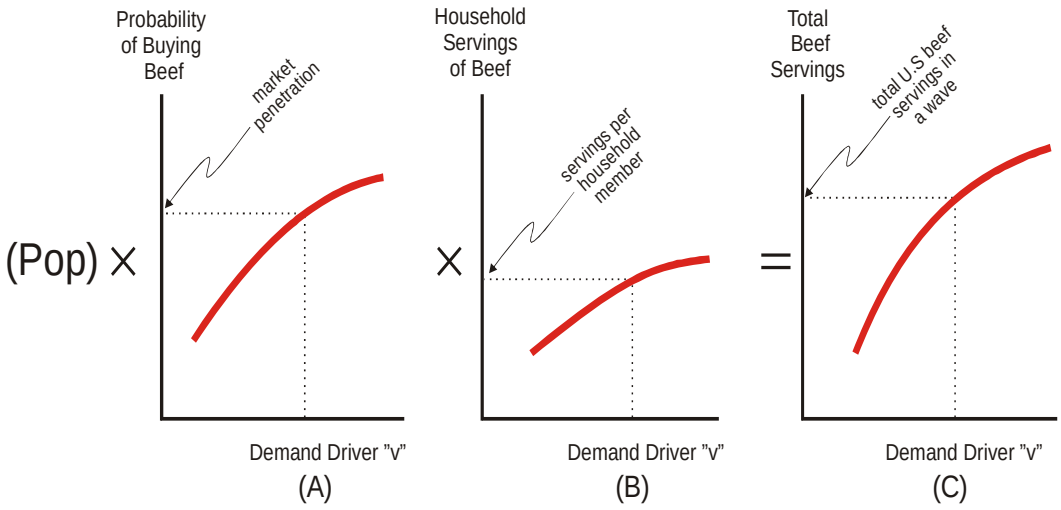


Figure 8. Theoretically deriving the demand for beef.

(1). $D = f_1(\text{Price}) + f_2(\text{Demographics}) + f_3(\text{Behavior}) + f_4(\text{Concerns}) + f_5(\text{Checkoff})$

Each function in equation (1) has one or more explicit coefficients that once estimated shows the response of market penetration to changes in each demand driver. Once those coefficients are estimated, the model is then used to derive the probability of consuming beef. The technical aspects of each f_i are left to the appendices.

To illustrate, suppose we have estimated the coefficient β_1 that is associated with price. Furthermore, the statistical properties of this coefficient are known. With that coefficient one can then show how market penetration changes with price while holding all other variables at preassigned levels. Since coefficients are estimated for each variable in equation (1), one can show the impact from changes in any of the demand drivers. The process of estimating these coefficients is accomplished with the use of probit models, a widely used estimation technique when the explanatory variable is either a 1 or 0. Once the probit estimates are established, it is one additional step to express the variable impacts in terms of the probability of buying beef (i.e., market penetration) (Greene). Again, the technical aspects of the estimation are left to the appendices.

A household must have purchased beef if any quantity of beef was served in the household during an assigned reporting period. The quantity served depends on the demand drivers but only for values among those who indicated buying some beef. As shown in Figure 8, first you buy beef then the quantity is determined among those buyers.

Define Y as the number of servings of beef per household member for a given two-week period. Unlike D above, Y takes continuous values since it is defined as the number of servings per household divided by the household size. Equation (2) suggests a function similar to (1) with the same demand drivers except with the addition of a variable capturing the fact that we are now dealing with those households who purchased beef.

(2). $Y = g_1(\text{Price}) + g_2(\text{Demographics}) + g_3(\text{Behavior}) + g_4(\text{Concerns})$
$+ g_5(\text{Checkoff}) + g_6(\text{Beef Consumers})$

Once the coefficients in (2) are estimated the responses illustrated in panel (B) of Figure 8 can be determined.

Estimation of equations (1) and (2) provide the core for measuring beef demand and

how it changes with those demand drivers included in the models. One must recognize that it is never possible to measure everything that influences demand and, as long as those omitted variables occur randomly, they should not influence the conclusions about the impacts of the included demand drivers. Since the empirical analysis is based at the household level, one fully expects for there to be many random events that cannot be modeled. That is the nature of dealing with non-aggregated data.

Beef Demand Model Estimates

Detailed counterparts to equations (1) and (2) are presented in Tables 3 and 4 with Table 3 giving the market penetration demand estimates and 4, the serving estimates. There are 79 coefficients for the buying model and 80 for the servings model. In both models the same demand drivers are included except for the last variable in the servings equation. This variable, known as an Inverse Mills ratio, essentially accounts for being a beef consumer derived from the probit model (Greene; Davidson and MacKinnon). These models will be used extensively in later sections to show the responses to each variable (see Appendix B).

Twenty-one categories of variables encompass the demand drivers included in the two tables with the definitions paralleling the discussions from Tables 1 and 2. Encouraging eating hot dogs (FDHOT), pizza (FDPIZ), lunchmeat (FDLUN), tacos (FDTAC), and fried chicken (FDCHK) were scored with the six degrees outlined in Table 2. These six variables reflect eating behavior or attitudes about foods that typically fit into the fast-foods category. During one reporting period a household scores each eating variable from 1 to 6 with a score of 4 being neutral. The coefficients for 1, 2, 3, 5 and 6 are shown and are all relative to the neutral level. This is a typical way for dealing with categorical variables where one of the categories is the base (Ward, 2004; Ward, Moon and Medina, 2002).

Taking doctors' advise about nutrition (ATDOC); eating regular meals (ATREG); counting calories (ATCAL); having more nutritional knowledge (NTKNO); planning nutritional meals (NTPLN); and importance of look, smell, and taste (NTLOK) is also scored using the six-point scale and the neutral base. Note again that the coefficients for the score of 4 are not reported since that level is the base. Consumer demographics are identified with DMMSZ being the market size; NDMINC, household income; DMAGE, household female age; DMEDU, female education; TDMFEM, female employment; and DTFEM measuring if the female is on a diet. Finally, NDMREG captures the four regions defined in Table 1.

Each coefficient shows the direction and magnitude of the impact depending on the

Table 3. Market penetration model based on probit estimates.

Market Penetration			Market Penetration (continued)		
	Coef.	t-values		Coef.	t-values
C	0.83715	16.72659			
FDHOT1	0.02765	0.59631	NTKNO1	-0.22781	-6.89672
FDHOT2	0.10327	2.70970	NTKNO2	-0.10924	-4.24170
FDHOT3	0.08329	3.95387	NTKNO3	-0.05440	-2.65423
FDHOT5	-0.01278	-0.61008	NTKNO5	0.08740	3.31127
FDHOT6	-0.25087	-11.14840	NTKNO6	0.13012	3.71959
FDPIZ1	-0.02952	-0.99874	NTPLN1	0.18467	7.49597
FDPIZ2	-0.02921	-1.28572	NTPLN2	0.19000	10.66522
FDPIZ3	-0.00679	-0.38290	NTPLN3	0.09502	6.15214
FDPIZ5	0.01868	0.76383	NTPLN5	-0.13488	-5.73212
FDPIZ6	0.01090	0.31358	NTPLN6	-0.25987	-7.55861
FDLUN1	-0.02235	-0.62394	NTLOK1	0.06315	3.65271
FDLUN2	0.02968	1.14750	NTLOK2	0.01273	0.78498
FDLUN3	0.05105	2.68123	NTLOK3	0.00272	0.18143
FDLUN5	0.02026	1.00873	NTLOK5	0.01362	0.74632
FDLUN6	-0.12441	-5.38905	NTLOK6	-0.03761	-1.44561
FDTAC1	0.10762	3.04582	DMMSZ1	-0.12547	-10.51833
FDTAC2	0.11810	4.60160	DMMSZ2	-0.07501	-4.07928
FDTAC3	0.02473	1.30870	DMMSZ3	-0.02472	-1.31073
FDTAC5	-0.09573	-4.07634	DMMSZ4	0.11921	6.20617
FDTAC6	-0.14050	-5.46169	NDMINC2	0.05988	5.18505
FDFCH1	0.00232	0.05804	NDMINC3	0.13130	9.42234
FDFCH2	0.03363	1.04112	DMAGE2	0.09789	6.74059
FDFCH3	0.01046	0.50249	DMAGE3	0.09625	6.38156
FDFCH5	0.01411	0.73083	DMAGE4	0.01826	1.14264
FDFCH6	-0.09034	-4.25957	DMAGE5	-0.19201	-11.50219
ATDOC1	0.00540	0.15036	DMEDU2	0.13248	9.34649
ATDOC2	-0.02039	-0.58873	DMEDU3	-0.02680	-1.91014
ATDOC3	0.00160	0.05061	DMEDU4	-0.23468	-16.72160
ATDOC5	-0.04717	-1.35423	TDMFEM2	-0.09770	-11.72522
ATDOC6	-0.10733	-3.36506	DTFEM2	0.03320	3.85713
ATREG1	0.14383	5.36803	NDMREG2	0.05573	4.30767
ATREG2	0.12313	4.80552	NDMREG3	-0.01817	-1.59087
ATREG3	0.12843	4.99242	NDMREG4	-0.06655	-4.93015
ATREG5	0.07005	2.20105	SQRTCHK	1.67333	2.92511
ATREG6	0.03013	0.60847	PC1	0.00270	0.30255
ATCAL1	-0.10784	-3.28127	PC2	0.03511	4.83538
ATCAL2	-0.04022	-1.50610	PR1	-0.11169	-11.69837
ATCAL3	0.02102	0.90553	PR2	-0.01407	-1.95553
ATCAL5	0.02380	0.87837			
ATCAL6	0.02290	0.73575			

numerical value and its sign. Statistical t-values to the right of the coefficients are a test of the statistical significance of the variables. Each t-value is a test that a particular variable is statistically different from the average household and any t-value greater than 1.96 shows the variable impact to differ from the average household with at least a 95% confidence level. As evident in Tables 3 and 4, most of the variables have strong statistical properties. It is hard to really see the impacts by just looking at the numbers so in subsequent sections the impacts will be shown graphically.

Beef checkoff activities enter the demand models as quarterly deflated expenditures per capita expressed in a square-root form as defined in equations (3). CHECKOFF is the national checkoff expenditure on promotions, consumer and industry information, first shown with Figure 7. Media costs historically change with inflation and sometimes even faster than inflation and using the deflation is a direct way of showing the real expenditures. Media costs are also related to coverage and putting the demand enhancing efforts on a per-capita basis accounts for the increased coverage costs. Equation (3) is expressed as a square-root function in order to allow for declining marginal responses to increased promotions (Forker and Ward; Capps, Bessler and Williams). This simply means that if the checkoff shifts demand, the gains are not expected to increase at the same rate with larger expenditure levels. Extensive uses of the checkoff responses are shown in a separate section of this report. At this point it suffices to highlight that the checkoff coefficients in the market penetration and servings models have the correct positive signs and are statistically significantly different from zero (i.e., the t-values are 2.92 and 2.45). This is the first step in the checkoff evaluation where the results clearly establish a positive impact on U.S. beef demand in both attracting more households to the beef market and then on how many servings are included in the two-week diet.

(3). $$SQRTCHK = \sqrt{((CHECKOFF / CPI) / POP)}$$

Dealing with Correlation Problems

Two sets of variables near the end of each table are PC and PR. PC is a weighted sum of the health variables outlined in Table 2 and specifically the concerns about fats, cholesterol, additives and preservatives. Normally, one would include each of these health

Table 4. Beef servings model estimates using ordinary least squares.

Beef Servings			Beef Servings (continued)		
	Coef.	t-values		Coef.	t-values
C	2.77491	13.01927			
FDHOT1	0.08107	0.90328	NTKNO1	-0.29142	-3.49881
FDHOT2	0.11671	1.63933	NTKNO2	-0.16668	-3.15769
FDHOT3	0.05889	1.41168	NTKNO3	-0.08561	-2.19514
FDHOT5	0.01885	0.47321	NTKNO5	0.05862	1.17350
FDHOT6	-0.29554	-3.94095	NTKNO6	0.22154	3.25768
FDPIZ1	-0.10493	-1.82723	NTPLN1	0.51007	8.27079
FDPIZ2	-0.08152	-1.85644	NTPLN2	0.39044	7.68923
FDPIZ3	-0.01066	-0.31509	NTPLN3	0.18336	5.26159
FDPIZ5	-0.05241	-1.17802	NTPLN5	-0.38179	-7.38868
FDPIZ6	0.22311	3.07317	NTPLN6	-0.61078	-6.76446
FDLUN1	-0.06413	-0.88126	NTLOK1	0.04224	1.23381
FDLUN2	0.02974	0.61157	NTLOK2	-0.04689	-1.55040
FDLUN3	0.06215	1.66374	NTLOK3	-0.01310	-0.47042
FDLUN5	0.04114	1.07300	NTLOK5	0.01350	0.40652
FDLUN6	-0.14684	-2.68275	NTLOK6	0.05378	1.03337
FDTAC1	0.28343	3.96722	DMMSZ1	-0.30144	-8.78314
FDTAC2	0.11947	2.25835	DMMSZ2	-0.26569	-7.30139
FDTAC3	0.05584	1.55133	DMMSZ3	-0.04733	-1.38604
FDTAC5	-0.16889	-3.38782	DMMSZ4	0.30481	7.08972
FDTAC6	-0.18849	-3.19105	NDMINC2	0.06476	2.84921
FDFCH1	0.10729	1.35184	NDMINC3	-0.02284	-0.61178
FDFCH2	0.17285	2.91829	DMAGE2	0.33568	10.38092
FDFCH3	0.13309	3.30111	DMAGE3	0.20921	6.11265
FDFCH5	-0.12075	-3.35402	DMAGE4	-0.03983	-1.35157
FDFCH6	-0.29753	-6.68916	DMAGE5	-0.56521	-11.37604
ATDOC1	0.00681	0.10033	DMEDU2	0.22601	6.21108
ATDOC2	0.06991	1.10898	DMEDU3	-0.05739	-2.15025
ATDOC3	0.03559	0.60439	DMEDU4	-0.45130	-8.20247
ATDOC5	-0.01235	-0.18714	TDMFEM2	-0.22871	-9.19775
ATDOC6	-0.09021	-1.39607	DTFEM2	-0.03564	-2.07954
ATREG1	0.27737	4.70738	NDMREG2	0.22480	8.35980
ATREG2	0.13846	2.55740	NDMREG3	-0.09037	-4.23742
ATREG3	0.12244	2.23902	NDMREG4	-0.00651	-0.22026
ATREG5	0.05638	0.93009	SQRTCHK	2.68051	2.45089
ATREG6	-0.18128	-1.70951	PC1	0.03829	2.20954
ATCAL1	-0.20094	-3.00066	PC2	0.07480	4.78985
ATCAL2	-0.08968	-1.81549	PR1	-0.26923	-9.13490
ATCAL3	0.00344	0.08029	PR2	-0.02321	-1.69125
ATCAL5	0.06157	1.19623	INVMILLS	1.55553	2.98703
ATCAL6	0.00716	0.12219			

measures directly in the models. Yet with known correlations among these health variables, a method of principal components is used where PC1 and PC2 are weighted sums of scores of the health variables. PC1 and PC2 are not correlated and are included in the models as shown in Tables 3 and 4. With the estimated coefficients associated with PC1 and PC2, it is a straightforward process to work back to the effects of each of the four health variables. All technical aspects of this procedure are place in the appendix while the results will be used later without going into the statistical details in the text (see Appendices B and C).

PR1 and PR2 are similar weights but for beef, pork and poultry prices. These prices were first shown in Figure 3 and there are strong correlations among these three prices. Once the coefficients tied to PR1 and PR2 are known as shown in Tables 3 and 4, the effects of the meat prices can be determined. Like that for PC, the technical aspects are in the appendices and uses of PR1 and PR2 are in the next several sections (see Appendix B).

The servings model included the last variable INVMILLS. Recall that the servings model is based only on those households who did buy some beef. The statistical issues are with possible selection bias since a subset of the population is being used. That is, we have selected only those households who purchased beef. This highly technical variable is used to determine if one needs to account for those conditions leading to becoming a beef consumer. If this variable were statistically no different from zero, one could estimate the beef serving model without concern for why households became beef buyers. If significant, as is the case, then the variable accounts for those reasons for becoming a beef buyer. This estimate is important to the overall serving model in that it prevents having certain statistical problems associated with sampling.

This section has established the models and their statistical properties. Rather than going into further statistical detail, in the next sections the results will be used to show the impacts of each demand driver in shifting the demand for beef. For the price effects, it is movements along the demand curve. Non-promotion demand drivers are first discussed then followed with a separate section dealing with the effects of the beef checkoff on beef demand.

Non-Promotion Demand Drivers

In the following series of figures, the models from Tables 3 and 4 are used to show changes in U.S. beef demand as each demand driver is ranged over the six-point scoring

scale. The red bars are the market penetration probabilities and the black lines plot the levels of beef servings. For every case, simulation techniques are used where all other conditions are averaged over actual household conditions except for the variable being controlled. This is equivalent to the average household during the simulation across the demand driver of interest (see Appendix D).

Eating Behavior

Figure 9 includes the estimated market penetration and number of servings per household member when considering the range of eating behaviors from encouraging consumption of hot dogs to not eating fried chicken. Each of the variables in Figure 9 in some way reflects the propensity to consumer fast foods and the expectation is that there is a positive relationship between encouraging the consumption of fast foods and beef. As a general rule, the results do show that relationship where both the likelihood of buying beef and the amount consumed mostly increase among those encouraging the use of these fast-food types. For example, among those households strongly discouraging the consumption of hot dogs, the likelihood of buying beef drops from over 80% to near 72%. Also, the servings per household member dropped from 3.65 to 3.45. Similar changes are seen for eating lunchmeat, tacos, and fried chicken. The only exception is with pizza where there appears to be some level of substitution between pizza and beef servings. While the numbers differ with each type of fast food, the overall conclusion is these eating behaviors do have an impact on the demand for beef where fast-food consumers are more likely to buy and increase the servings of beef in the household. Note that even when the household discourages the consumption of these food items, the likelihood of buying beef is still in the 70% range and the servings remain in the 3.4 to 3.7 levels. That is, the discouraging of eating these foods does not totally drive consumers from the beef market.

An important part of the analysis is that the models are capturing the effects of behavior and that assures that later checkoff analyses are studied within the sphere of influence from the other demand drivers.

Household Attitudes and Concerns

Buying and consumption behavior should be influenced by the opinions and health concerns among households. As indicated earlier, households in the survey were asked to score their attitudes and health-related concerns using the six-point scale outlined in Table

2. For several of these potential demand drivers, the direction of impact is expected while for others it is more difficult to gauge prior to estimating the demand models. Six variables are identified as good indicators of general attitudes about food use with the questions closely tied to nutrition. In Table 5, the impact on beef demand is shown for these six variables starting with seeking advice from your doctor about nutrition and ending with the importance of look, smell and taste attitudes. The last four measures in the table deal with health concerns. For each column in Table 5, the probability of buying beef and servings are estimated over the entire household sample while controlling on the scale for each particular explanatory variable.

A quick review shows that "Seeking Doctor's Advice" and "Importance of Looks, Smells, and Taste" have the least impact among the six nutritional-type variables. In stark contrast, the "Importance of Planning Nutritious Meals" and "State of Nutrition Knowledge" have profound impacts on the demand for beef. In some ways these two variables seem to have contrasting impacts.

The female household head was asked about her nutrition knowledge relative to others. For those perceiving themselves with more knowledge, both the probability of consuming beef and the servings per capita dropped to 72% and 3.41 servings on average. When less informed, these levels increased to 82% and 3.70 servings. While the scoring is subjective since it is relative to others, its impact on decision making is considerable.

Nearly the opposite is seen for the "Importance of Planning Nutritious Meals" where the market penetration increases from 70% to nearly 83% and servings increase from 3.05 to 3.88 servings over the six-point scale. Clearly, consumers view beef positively when planning nutritious meals. This range in the score is one of the largest among all of the demand drivers. Similarly, when consumers indicated the value of eating regular meals the servings increased from 3.36 to 3.75 servings per household member in a two-week period.

Obesity is a problem in the U.S. and households do view beef negatively when expressing concern about calories. As consciousness about calories increases, the probability of buying beef drops from 79% to 76% and servings decrease from 3.54 to 3.41 servings per household member. Calorie impact on beef demand is negative, yet the range of change is substantially less than those attitude variables with positive impacts.

The last four variables in Table 5 relate to being concerned about specific health-type measures such as concerned about cholesterol. Somewhat surprising is the low impact of these variables on the likelihood of buying beef during a two-week shopping period. For

example, when moving from not concerned to completely concerned about cholesterol, the probability drops from 80.4% to 79% or less than one percentage point. Very similar small changes are seen with the other three market penetration measures. In contrast, the quantity consumed among beef buyers shows a much greater relative impact. Take cholesterol again, beef servings per household member drops from 3.73 to 3.52 as concern about cholesterol increases. An almost identical drop is seen for the fat variable. Specifically, concerns about fats and cholesterol impact beef demand negatively but almost totally through the amount consumed among existing buyers rather than losing potential buyers.

Table 5 is revealing in that among the ten demand drivers shown, nearly all of the market penetration changes are from the nutrition-type variables. These variables influence both market penetration and servings while the health variables basically influence the number of servings.

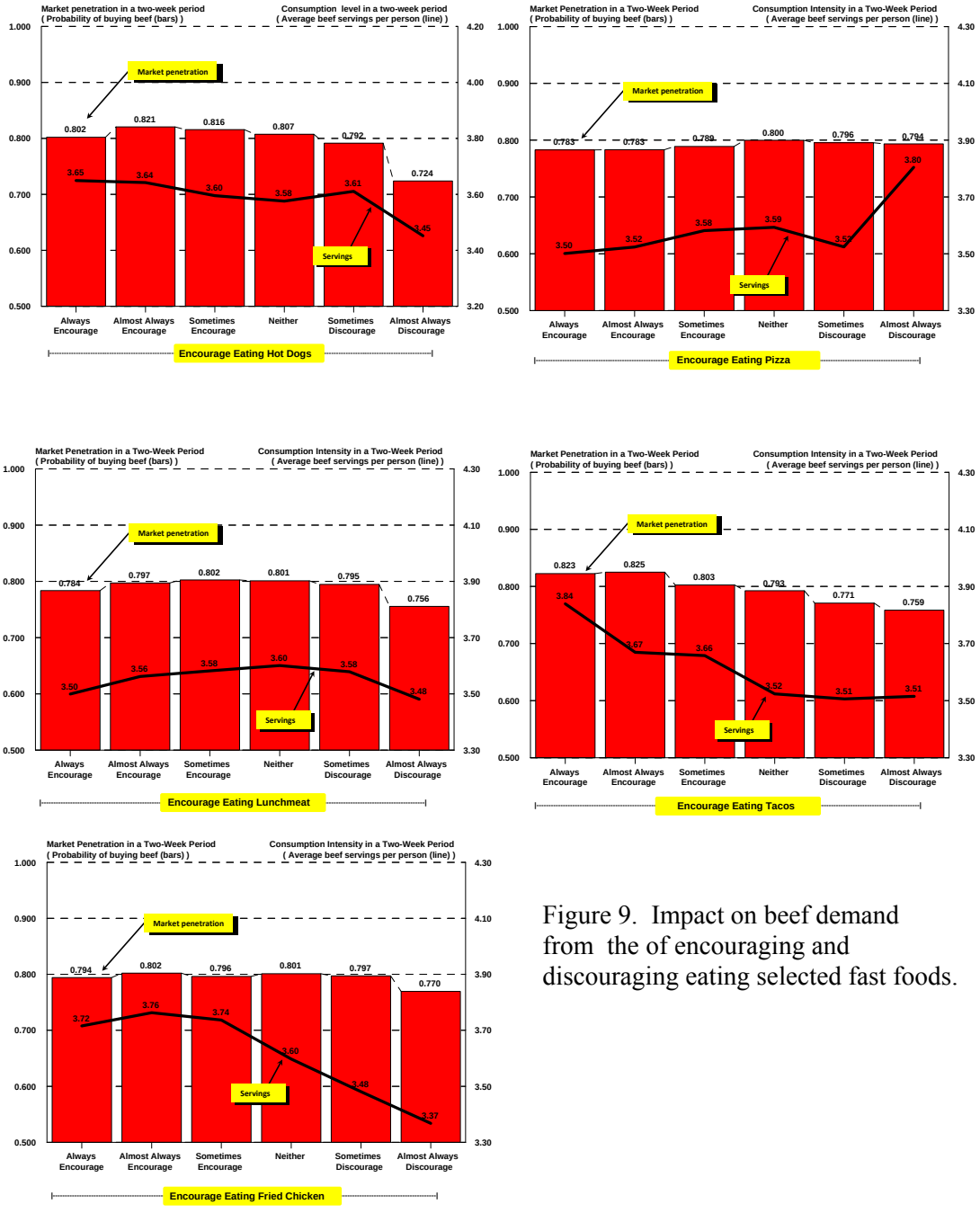


Figure 9. Impact on beef demand from the of encouraging and discouraging eating selected fast foods.

Table 5. Estimated market penetration and beef servings across households' attitudes and health concerns.

	Market Penetration	Servings per capita	Market Penetration	Servings per capita
	Doctor's Advice on Nutrition		Important to Eat Regular Meals	
Completely Agree	0.789	3.61	0.836	3.75
Agree Mostly	0.782	3.68	0.832	3.62
Agree Somewhat	0.788	3.64	0.833	3.61
Neither	0.829	3.50	0.661	3.47
Disagree Somewhat	0.775	3.62	0.820	3.57
Disagree Mostly	0.759	3.58	0.810	3.36
	Conscious of Calories		More Nutrition Knowledge	
Completely Agree	0.760	3.41	0.722	3.41
Agree Mostly	0.778	3.48	0.756	3.45
Agree Somewhat	0.794	3.54	0.771	3.50
Neither	0.809	3.72	0.829	3.72
Disagree Somewhat	0.795	3.59	0.808	3.56
Disagree Mostly	0.795	3.54	0.819	3.70
	Plan Nutritious Meals		Important of Look, Smell, Taste	
Completely Agree	0.827	3.88	0.810	3.59
Agree Mostly	0.828	3.76	0.799	3.53
Agree Somewhat	0.805	3.61	0.795	3.57
Neither	0.761	3.43	0.780	3.57
Disagree Somewhat	0.743	3.18	0.797	3.59
Disagree Mostly	0.706	3.04	0.784	3.66
	I am Concern about Fats		I am Concern about Cholesterol	
Completely Agree	0.790	3.52	0.789	3.52
Agree Mostly	0.793	3.56	0.793	3.56
Agree Somewhat	0.796	3.60	0.796	3.60
Neither	0.799	3.64	0.799	3.64
Disagree Somewhat	0.801	3.68	0.802	3.69
Disagree Mostly	0.804	3.72	0.805	3.73
	I am Concern about Additives		I am Concern about Preservatives	
Completely Agree	0.797	3.56	0.799	3.62
Agree Mostly	0.795	3.57	0.796	3.59
Agree Somewhat	0.793	3.58	0.793	3.57
Neither	0.792	3.60	0.790	3.54
Disagree Somewhat	0.790	3.61	0.787	3.52
Disagree Mostly	0.789	3.62	0.784	3.49

Household Demographics

Demographics are measures for many underlying characteristics of consumers. Age implies changing lifestyles, health status, maturity, and experience just to name a few. Education may signal something about the decision-making process as well as a broader set of values and life experiences. It does not imply one is better or worse than another, it just suggests that buying behaviors may differ. Female employment may provide an indirect measure of a greater demand for convenience foods given the person may be away from home more than someone working at home. Similarly, incomes would be expected to impact the demand for beef. Finally, the household residency in terms of city size says a lot about the underlying cultures, habits, time limitations, lifestyles, and available alternatives. From the survey we know the residency market size but do not know the underlying reasons if beef demand differs across markets. Below these demographics are discussed without any implied order for presenting each demand driver.

Each female head of the household indicated her age using the range shown in Figure 10. Age impact on beef demand is substantial with changes seen in market penetration and the number of beef servings among those households who purchased beef in the shopping periods. Middle-age households (35 to 54 years) show the highest market penetration with nearly 82% of them buying beef in the time period. Market penetration declines with age where for those over-65 years of age, the probability of buying beef is 74% giving an eight-point spread from the highest group.

Even more profound is the drop in beef servings per household member across ages. The 35/44-year group shows 3.83 servings per household member then servings drop almost exponentially with aging. For the 65 years and older, the servings per capita decline to 3.10 servings per person. That is nearly a 19% drop in beef servings between these two age groups. Even with this decline, all age groups still show a preference for beef in that all groups have penetration of 70% or above and serving levels of at

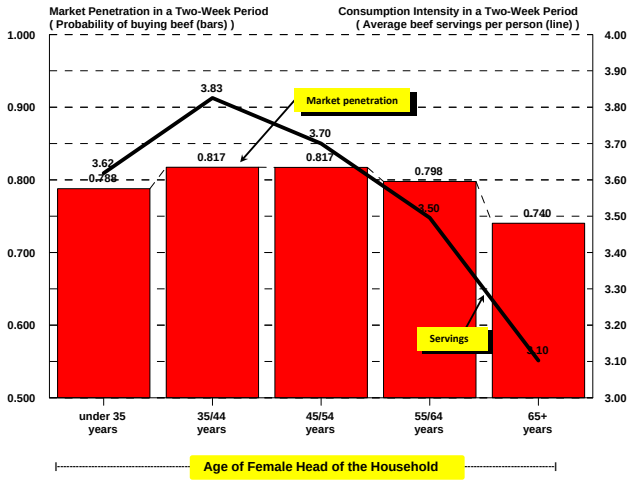


Figure 10. Impact of age on beef demand.

least 3.0.

Figure 11 shows market penetration and servings across four education levels ranging from no high school to college graduate. Higher education has a clear negative impact on beef demand in terms of both market penetration and servings. Market penetration drops from the 80% level to around 75% among those completing college. Likewise, beef servings per household member drops from 3.84 to 3.32 over the four education levels.

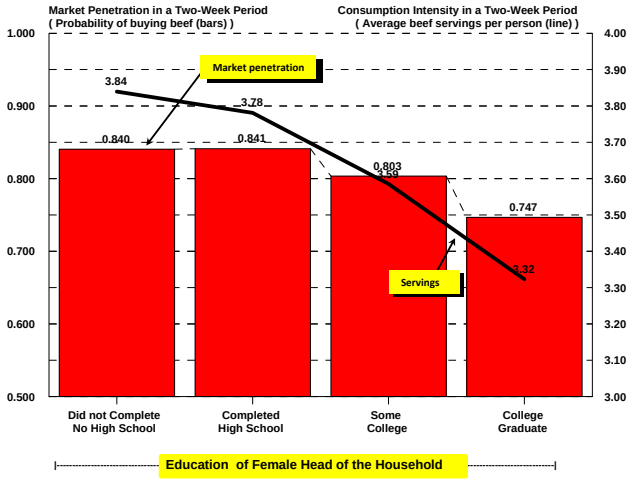


Figure 11. Impact of education on beef demand.

Figures 10 and 11 provide two important demographics with both negatively driving the demand for beef. The U.S. population is aging and fewer individuals are in the lowest education level. While statistically these two variables are not correlated as one might have expected, their combined effects definitely produce a downward pressure on the demand for beef since the demographic trend is for a more educated aging population.

Two questions specifically directed to the female head of the household were the employment status of the female and if she was on a diet. The implications of both were expected to negatively impact beef demand.

In Figure 12 both situations are addressed with the two left bars showing the employment status and the right two bars reflecting dieting. Market penetration increases from 77% to 82% when the female head is not employed. Concurrently, beef servings increase from 3.42 to over 3.76.

If this is a reflection of the demand for convenience because of employment time constraints, then Figure 12 points to the need for more convenient beef forms. The link between employment and convenience is conjecture but it is one possible argument for the responses seen in this figure.

Reference back to Table 5 and the calorie question pointed to the negative impact of weight on the demand for beef. Actual dieting behavior has a slightly different impact. When the female is on a diet the models indicate that beef servings drop from 3.61 to 3.50 but the level of market penetration increases slightly. That is, the female dieting behavior does not stop the shopper from purchasing some beef during the shopping period. A careful review of the conscious of calorie question points to some inconsistency even with those responses where the neutral scores showed the highest penetration and servings level. Overall, one can conclude that weight issues impacting the demand for beef is generally negative but the results are not as conclusive as seen with many of the other demand drivers.

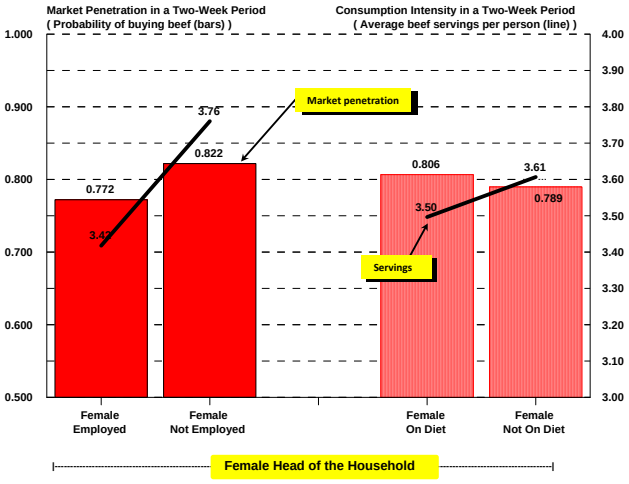


Figure 12. Impacts of employment and dieting.

To complete the demographics Figures 13 and 14 illustrate the impacts of income and market size using the same format from the previous few figures. Household incomes were grouped into those under $40,000 per year, those with $40,000 to $69,900, and then those $70,000 and over. These broader income groups were used since they conform with the general population categories of purchasing power and some indication of wealth. The expectation is that beyond certain higher income levels the relationship between food consumption and income is weaker. In fact, Figure 13 shows that between the lower to middle incomes both market penetration and serving levels increase with market penetration increasing by 4 percentage points while the servings gains are quite small. From the middle to higher income

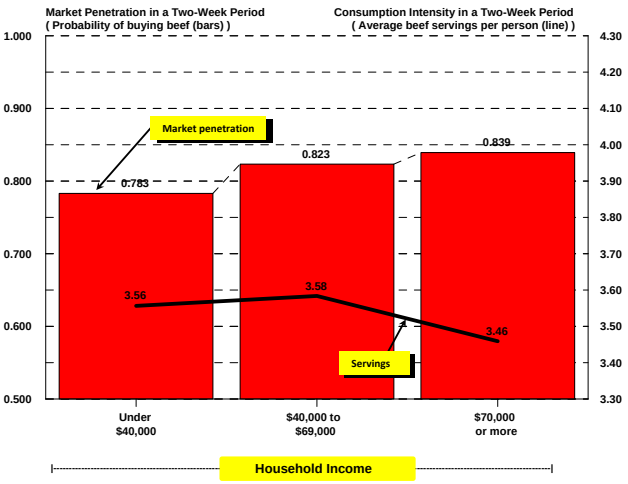


Figure 13. Income impact on beef demand.

($70,000 plus) market penetration continues to increase by about half that seen between the lower to middle income groups. Servings per household member dropped with this higher income category as seen with the movement from 3.58 to 3.46 servings. Volume per capita has dropped with the highest income level and the data do not provide any insight into the forms of beef consumption (e.g., steaks or ground beef). Market penetration rises with income but the volume per household member does not.

As first shown in Table 1, about 43% of the households live in cities of one million or more people and 22% reside in the rural markets. These population distributions encompass many differences between consumers from cultural practices and racial mix. An unfortunate deficiency of the database is that it does not account for race, and the residency size is possibly picking up some of that difference confounded with many other differences found across metropolitan areas.

The bars in Figure 14 show a significant decline in market penetration as one moves from the rural areas to the larger population centers. Among the rural households, market penetration stands at nearly 85% compared with the largest cities (over one million) the penetration is estimated to be 77%, again averaged over the households. Even more dramatic is the decline in servings per household member over the residency sizes. Rural households show over 4.0 servings per household member for a buying period (wave) and the levels drop rapidly to near 3.40 servings in the larger cities. This decline across the residency sizes is among the most pronounced among all of the non-promotion variables. Only "planning nutritious meals" discussed with Table 5 is comparable.

Figures 9 through 14 and Table 5 illustrate the impact of important beef demand drivers and their relative impacts. Each of these responses have important implications for the beef industry and specifically the Beef Board as will be discussed in the conclusion. At this point we have measured the impacts of demand drivers with the inclusion of the beef checkoff in

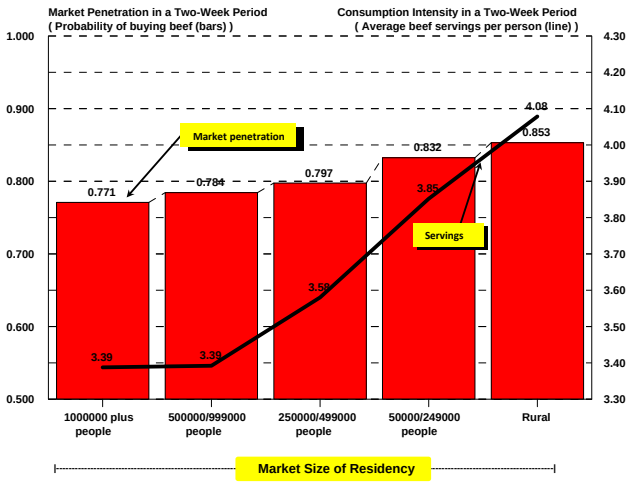


Figure 14. Beef demand across residency sizes.

the model. In the next section we turn to the primary focus of the analysis, the impact of the checkoff on beef demand while recognizing that the impacts of both promotion and non-promotion drivers have been estimated simultaneously. That is, all conclusions are drawn from estimates while accounting for the effects of other factors impacting beef demand.

Effectiveness of the Beef Checkoff

Beef demand is a product of market entry and consumption as indicated in all of the prior discussion. Both entry into the market and the amount consumed should be a function of information in all forms. Some information sources are through experience and exposure and potential consumers may not even be aware of the way new messages impact their buying decisions. More formal information such as provided through the beef checkoff is focused, informative, and sometimes targeted to specific demographics. What we know for almost all commodity promotion programs is that demand will continue to exist without these producer-funded programs. That is, there will be some level of market penetration and some level of consumption per household member without generic promotion programs. The obvious question then is if the generic efforts impact beef demand. Do they generate a positive shift in beef demand and, if so, how much is attributed to attracting people to the market compared with consuming more per buyer? Past research has shown generic promotions of beef positively impact beef demand (Ward, Moon and Medina). Similarly, the promotion coefficients from Tables 3 and 4 also point to a statistically significant positive impact of the beef checkoff programs. In the next several sections, the effectiveness of the beef checkoff activities is discussed in considerable detail with the final goal of showing the rate-of-return to these producer driven demand enhancing efforts.

The checkoff coefficients in Tables 3 and 4 were measured with quarterly expenditures on promotions and consumer/industry information programs. As shown in equation (3), the quarterly expenditures were deflated and expressed on an equivalent per-capita basis over the periods from 1986 through 2008. These expenditures were merged with the households by matching the quarter values to the household shopping periods or wave. The premise is that within those waves corresponding to a specific quarter, the public was equally exposed to the checkoff information. Then determining the extent of response is the empirical research challenge. In the following analysis, the checkoff coefficients are considered with their impacts on market penetration and servings per household member.

Afterwards, shifts in total U.S. demand resulting from the checkoff activities are documented.

Checkoff Impacts Across Time

Model estimates, over the full 22-year period from 1986 through 2008, show the beef checkoff coefficient to be positive and statistically significant (i.e., see the t-values for the SQRTCHK variable in both tables). One can be 95% confident that the impact of the checkoff on beef demand is statistically different from zero. It has a statistically significant effect on beef demand. The same models were estimated over shorter data periods starting with 1987 through 2002 and then adding one additional year for each new set of estimates. With each updated model, new checkoff coefficients were estimated along with their statistical properties. For each increment in the data starting with the 1987-2002 base, the beef checkoff coefficients are statistically significant thus establishing that the beef checkoff impact is consistently statistically different from zero with more than a 95% confidence level (see Appendix C).

During the years since 2002, the beef industry has experienced shocks that could directly impact the effectiveness of the beef checkoff programs. From litigations to food safety concerns, the ability to shift demand through generic advertising may have been adversely effected. Likewise, growth in the use of the internet and print media contrasted with national television are alternatives for reaching individual households. An obvious question is if such changes have influenced the effectiveness of the beef checkoff efforts.

Beef checkoff coefficients cannot be directly compared across time simply because the estimates are not independent of the scale of the data. To compensate for scale differences, each coefficient was normalized by multiplying the coefficient by its standard deviation and then dividing by the standard deviation of the market penetration or servings depending on the two models. This process gives standardized coefficients that can be compared and specifically for seeing if there has been any underlying change in the checkoff effectiveness. In Figure 15 these standardized coefficients are shown first for market penetration and then for beef servings. The actual magnitude of each coefficient is not as important as the relative values. If the coefficients within each plot were the same across time, one would conclude that the checkoff promotion effectiveness has remained stable since 2002 and a casual look at the values point to considerable change with the added years.

Starting with the year ending 2002 and progressing forward, the effectiveness of the

beef checkoff dropped substantially between 2002 and 2003. The standardized coefficients continued to decline until the 2007 period where slight improvements are seen. What this figure means is that for the same dollar of checkoff expenditures, it generally has been less effective in tracking new consumers to the beef market relative to the 1990's. Even so, the checkoff still attracts consumers to the beef market.

Next in the lower portion of Figure 15, standardized beef checkoff coefficients are presented for the servings models. The effectiveness of the beef checkoff dollar to increase the number of beef servings per household member declined since the 1987-2002 period. The decline was the greatest with the 2003 addition as was true for the market penetration. From 2004, the effectiveness impact on servings increased slightly up to 2005. Beyond 2005, the servings effectiveness remained more stable but never again reached the 1987-2002 levels. Combined with the estimate t-values, the coefficients point to a consistently positive impact of the beef checkoff but evidence of some declining effectiveness since 2002. One can only conjecture as to what factors may have contributed to the decline in effectiveness, but part may be due to the media mix and food safety concerns seen almost daily in the press.

Market Penetration, Servings and the Beef Checkoff

Both market penetration and serving changes attributed to the beef checkoff depend on the coefficients discussed above and the level of checkoff activities. It could be that the

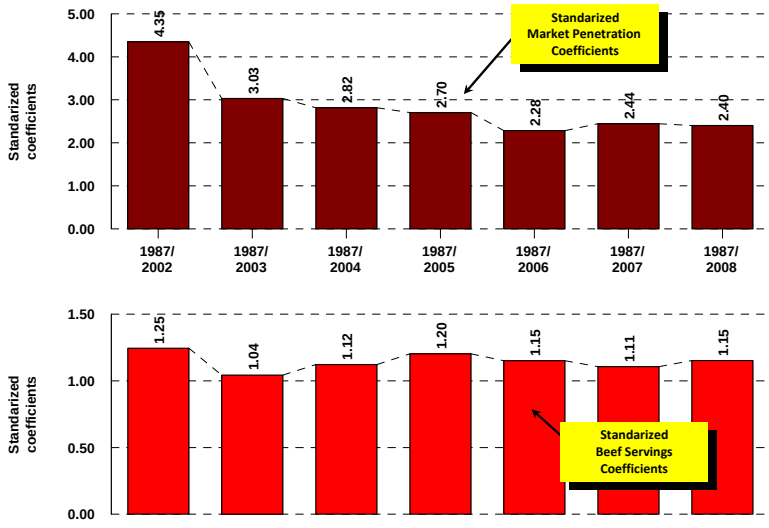


Figure 15. Standardized beef checkoff coefficients over time.

effectiveness declined but the expenditure levels were increased thus possibly showing increases in beef demand. Of course, the opposite is possible. To gain further insight into beef checkoff's ability to shift demand, the probability of buying beef and the number of beef servings per household member are estimated with and without the actual checkoff expenditures. Demand without the checkoff is estimated by predicting market penetration and servings assuming zero expenditures and then averaging across the households. That is, the predicted values are averages over all of the other demand drivers except for the generic promotion activities. Next, the same averages are calculated but this time based on actual checkoff levels. Any differences in the averages are attributed to the checkoff expenditures and effectiveness. It should be clear that if the checkoff coefficients were zero there would be no difference between the averages for either market penetration or servings. Figures 16 and 17 are used to show these averages and the gains across time, again recorded for the same time periods illustrated in Figure 15.

First in Figure 16, the average probability of buying beef is quite similar across the time periods estimated starting with the 1987-2002 period. The dark red bars are the predicted averages with the actual checkoff expenditures and show the percentages dropping from 81.8% to 79.4% between the extreme points. Then the lighter bars are similar averages except for setting the checkoff dollars to zero. The differences for each period are plotted in the lower portion of the charts.

With the complete removal of the checkoff activities, consumers still purchase beef

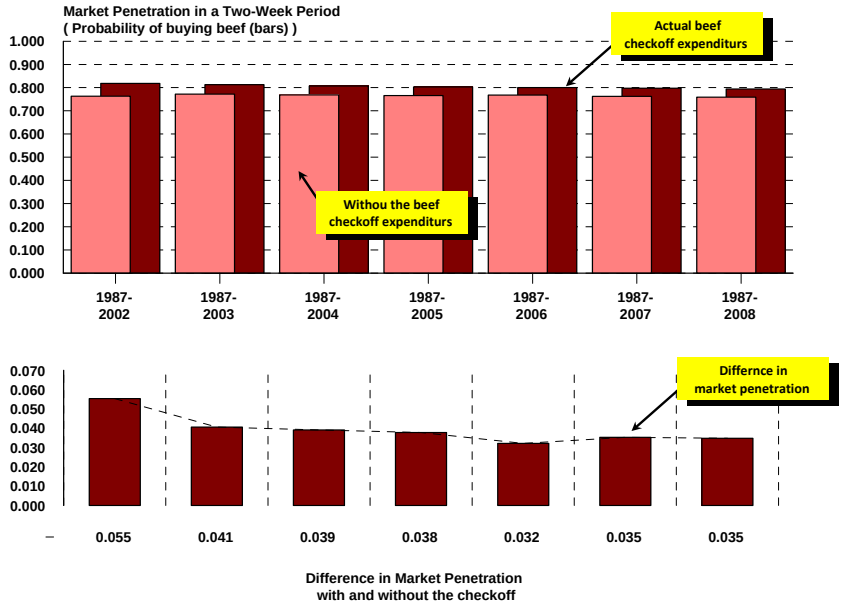


Figure 16. The impact of the beef checkoff on market penetration.

with the probabilities in the range of 76% of the population buying beef in a shopping wave. As expected, people buy beef without the beef checkoff. Yet the analysis shows that market penetration in the extreme of with and without the generic efforts differs from 3.5 to 5.5 percentage points. That is, the generic programs have the ability to change the probability of buying beef somewhat in the range suggested with these differences. Comparing these ranges to the other demographics establishes that the other demand drivers can create greater differences in the likelihood of buying beef than expected from the promotions. Also, the differences generally show a decline from the first period with the differences dropping from the 5.5 level. Part of that decline is attributed to the lower effectiveness levels first identified in Figure 15.

Using the same methods, servings per household member are predicted and plotted in Figure 17. Like the average market penetration with the checkoff, average beef servings per household member dropped from 3.69 to 3.57 between the beginning and ending time periods with actual checkoff expenditures. For the extreme of no generic activities, the servings range from 3.59 to 3.44 by the 1987-2008 period. Differences between the bars are direct indications that the beef checkoff positively shifted the demand for beef in terms of total servings and, in fact, the average gains in servings actually increased over what would have occurred in the absence of the beef checkoff. As a guideline, the results in Figure 17 point to gains in servings per household member to be in the range of .10 to .13 servings in

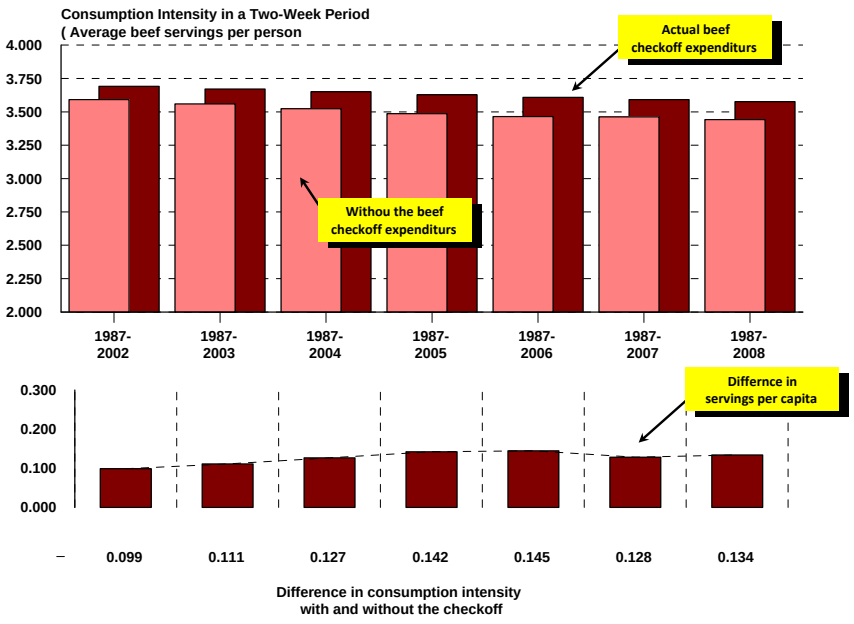


Figure 17. Changes in beef servings attributed to the beef checkoff.

a two-week consumption period. Compared to the averages with the actual checkoff promotions, this represents a maximum of a 2% to 4% gain in servings over what would have been predicted without the programs.

These last three figures establish that the generic promotions have indeed shifted the demand for beef when considered over the life of the programs since 1987.

Checkoff Impact between 1987-2002 and 2003-2008

An alternative approach to seeing the effects of the checkoff is to compare the gains predicted with and without the checkoff for the 1987-2002 years with those for the subsequent years. Coefficients from 1987-2002 and 1987-2008 were used for estimating the two impacts. This approach differs in that the latter period only include years since 2002 (see Appendix D).

Table 6 shows the estimated gains with this approach including the dollar value of the gains based on a household member. For the 1987-2002 years, the likelihood of buying beef differs by 5.5 percentage points based on with and without the beef checkoff. Now, of the 2003-2008 years, the difference drops to 3.0 percentage points. Quite apparent is the decline in market penetration between the two time spans. Servings differ by approximately .10 and .11 servings per household member between the same periods. Note that both the market penetration and servings decreased between 1987-2002 and 2003-2008.

A beef serving is very close to .388 pounds of beef. Using that factor, the servings

Table 6. Average household response with and without the beef checkoff during a shopping occasion.

	With Checkoff	No Checkoff	Gains
Probability			
1987-2002	81.8%	76.3%	5.5
2003-2008	78.8%	75.8%	3.0
Servings			
1987-2002	3.69	3.59	0.10
2003-2008	3.42	3.31	0.11
Expenditures			
1987-2002 *($2.82)*	$4.06	$3.95	$0.11
2003-2008 *($4.03)*	$5.36	$5.19	$0.17

gains translate into .038 and .043 pounds per household member. During the earlier years the average retail beef price was $2.82 per pound compared with $4.03 between 2003-2008. Multiplying these average prices gives a substantial increase in household expenditures per member for the latter period with the $-per-member change from $0.11 per pound to $0.17 in the more recent years.

Clearly, the higher prices substantially increased the value of the promotion gains. Table 6 is still in terms for probability and servings. Total demand is a product of both market penetration and servings multiplied by the population and servings conversions. We will turn to that conversion in the next section to show the full impact of the beef checkoff. Table 6 is also the extreme assuming no checkoff expenditures and that level actually never took place over the study periods. There has always been some level of generic activity.

Rate-of-Return to the Beef Checkoff

Actual beef checkoff activities were first illustrated with Figures 6 and 7 and clearly there were never periods of absolutely no checkoff demand enhancing expenditures. An approach to understanding the impact of the programs contrasted with Table 6 would be to determine the marginal gains from incremental increases (or decreases) in the overall programs. With this method one can show the percentage change in beef demand associated with different percentage reductions (or increases) in the checkoff expenditures. For example, assuming that the total checkoff efforts had been only 80% of the actual expenditures, how much would the beef demand have declined? We know demand would have declined because of the market penetration and servings coefficients, but the amount of demand change still has to be derived.

Total beef demand is a product of the U.S. population times market penetration times the servings per household member. This gives total U.S. servings in a shopping period or wave. We know that a serving is equivalent to .388 pounds of beef. This weight factor times the total servings give a measure of beef demand per shopping period and there are 26 shopping periods in a year. Multiplying the number of periods gives an average total beef demand, again averaged over the household characteristics and prices.

Figure 18 reports the changes in total beef demand with reductions in the overall beef checkoff expenditures expressed in ranges of 80%, 60%, and 40% of the actual checkoff expenditures. The negative bars show the estimated reductions in beef demand attributed to the reductions in the generic efforts. Comparing the impacts between 1987-2002 and

2003-2008 differ because the impacts differ and the checkoff expenditures also differ between the two periods.

If the beef checkoff were only 40% of the actual levels for the more current years, beef demand would be expected to be 2.55% less compared to the actual programs. At the 60% and 80% levels, demand would have declined by 1.57% or .74%. While the negative impact for 1987-2002 is larger, the patterns are very similar between the two periods. As a broad guideline, this figure points to a generalization that for each 10% reduction in checkoff expenditures the demand for beef can be expected to decline by about one-half a percentage point (0.4% to 0.5%). The elasticity of checkoff promotions is near .0004 averaged over the 2003-2008 data period (i.e., the elasticity $\xi_{checkoff} = .0004$).

For the earlier period, the checkoff elasticity is closer to .0005 compared with the more recent value of .0004 thus showing the change in effectiveness between the two comparison periods. To be precise, the average promotion elasticities are $\xi_{1987\text{-}2002f} = .00052$ and $\xi_{2002\text{-}2008} = .00039$.

For complete clarity in Figure 18, the -2.55% drop in demand for the 2002-2008 period is a result of a 60% decrease in the checkoff expenditures. Similarly, the -1.57% decrease results from a 40% reduction in generic expenditures and finally the -.74% decline in beef demand is for the initial 20% reduction. To emphasize, we are now talking about the full change in beef demand accounting for changes in both market penetration and the frequency of serving beef among beef buyers.

The dollar value of any of these changes in demand obviously depends on the

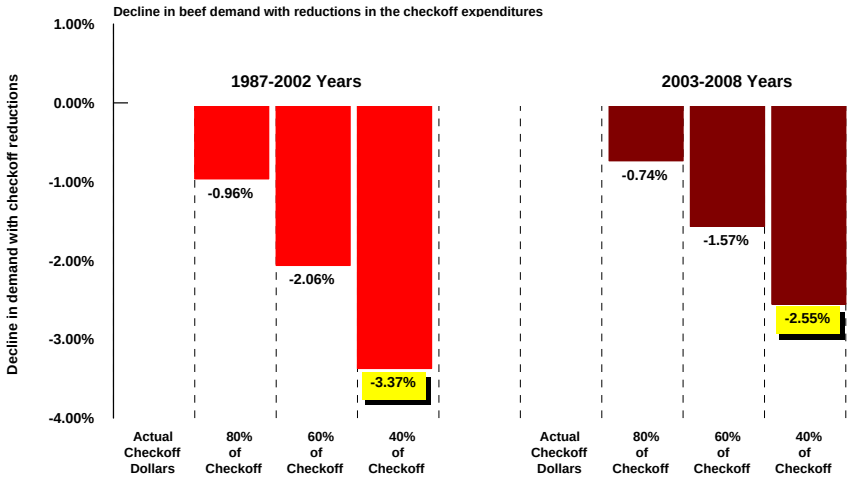


Figure 18. Simulated decline in beef demand attributed to reductions in the beef checkoff.

prevailing beef prices. In Table 5 the average retail beef price was $2.82 per pound over the 1987-2002 period and $4.03 for 2003-2008. For the same shift in demand between the two periods, the dollar value is potentially greater with the higher prices. The quantity impact of the checkoff could be less in the more recent years, but the value considerably higher because of the stronger retail beef prices since 2002. Knowing this dollar value is an essential step in determining the dollar gains attributed to the checkoff.

In Figure 19 the dollar impact of the beef checkoff is estimated. On the bottom axis, the quarterly average national checkoff expenditures are shown with the base average of $8.49 million per quarter over the 1987-2002 years and $8.06 million per quarter since then. All of the beef demand up to this figure has been expressed at the retail level, yet the checkoff expenditures are a cost to producers closest to the liveweight market level. Given the linkage between retail, boxed beef, and liveweight, it is a straightforward calculation to express value gains at the live weight-equivalent level. This conversion process is set forth in Appendix E where changes in retail prices and beef consumption are expressed in equivalent values at the liveweight levels.

Starting with the base checkoff averages for either period, checkoff expenditures are increased or decreased in increments of plus or minus 10%. Then the total value in demand is predicted for the equivalent liveweight level (again see Appendix D). Change in that value is the marginal revenue associated with incremental increases or decreases in the checkoff expenditures. Dividing the net marginal revenues (marginal revenue minus marginal promotion costs) by the changes in the marginal expenditures gives a direct estimate of the marginal rate-of-return to the beef checkoff programs. Above each bar in Figure 19, these

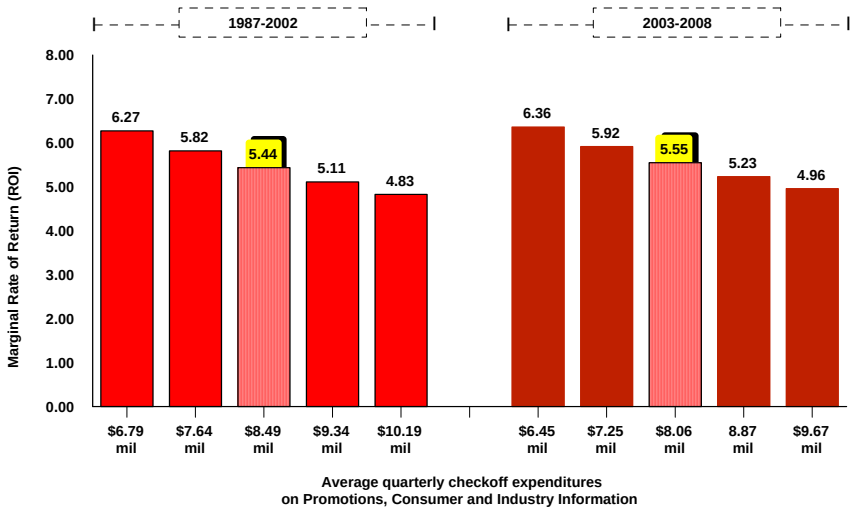


Figure 19. Estimated rate-of-return to the beef checkoff at the liveweight level.

rates-of-return are shown. At the average expenditure levels for both periods, the rates-of-return to beef producers are shown to be 5.44 and 5.55 for the 2003-2008 period. This rate is something that has been reasonably consistent over several study phases. At the average, an incremental dollar increase in checkoff efforts generates an additional $5.55 back to producers at the equivalent liveweight level. Clearly, this result has stood the test of time being quite robust (Ward. 2004)..

Between 1987-2002 and 2003-2008 the average liveweight price increased from 69.5 cents per pound to 87.5 cents per pound of liveweight-equivalent beef. Clearly, the marginal revenue or value between the period is partially due to these price differences. In fact, if the 2003-2008 prices had remained the same in 1987-2002, the marginal rates-of-return at the mean checkoff level would have been 3.67 compared with 5.55. Approximately 36% of the value gain is attributed to the fact that beef prices were nearly 26% higher during the 2003-2008 years. This does not change the meaning of 5.55 but simply helps identify the contributing factor embedded in the liveweight-equivalent dollar values.

Checkoff Impact on Liveweight Prices

Since all checkoff assessments are on a per-head basis, expressing the checkoff impacts on an equivalent liveweight per hundredweight (cwt) is another way for visualizing the effectiveness of the beef checkoff. From the last few charts, we know the promotion elasticities showing the impact on liveweight demand for specific changes in the generic promotions. For a given level of checkoff activities and liveweight price, the models predict the pounds of beef demanded. These values are all derived from the initial retail demand estimates.

Over the more recent years (2003-2008), average liveweight price per hundredweight ($ per cwt) was $87.55 for the corresponding pounds of liveweight-equivalent beef. Changes in the checkoff dollars create shifts in the retail demand for a given retail price and the equivalent liveweight price. A reduction in promotions shifts the demand to the left while holding price fixed. That is, for the same price less beef would be consumed with reductions in the promotions. Given we now know the demand curve, one can calculate how much the liveweight price would have to decrease to keep the same level of beef consumption before the checkoff dollars were decreased. The difference between the original price and the new lower price is the change in liveweight price attributed to reductions (or similarly increases) in the checkoff efforts.

In Figure 20 these changes are shown starting with the average liveweight price of $87.55 per cwt for the 2003-2008 period and for the actual checkoff expenditures over the same years. Now reduce the checkoff expenditures by 10% of the average and demand declines for the same liveweight price. Alternatively, for the same quantity demanded the liveweight price would have to be reduced to clear the market. Using the model estimated price elasticity of -.52, a 10% reduction in the beef checkoff leads to an equivalent liveweight price decrease from $87.55 to $87.49 or $0.06 per cwt. Suppose the checkoff was reduced by 30% of the average for the period, then the model points to an approximate $.20 per cwt reduction in the liveweight price or a price change from $87.55 to $87.35 per cwt. Figure 20 illustrate the liveweight price equivalence within a reasonable range of adjustments in the generic promotion activities. One does need to be careful extrapolating the adjustments too far outside of the range of promotion expenditures actually observed. The lower portion of Figure 20 shows the changes in equivalent price per head assuming a 1300 pound animal. As a general guideline, each 10% adjustment in the checkoff dollars creates about a $0.89 per head. Similarly, a 30% reduction suggest a $2.60 per head lower price. These estimates are based on the average household and actual distribution of the checkoff dollars but with the total checkoff expenditures being changed.

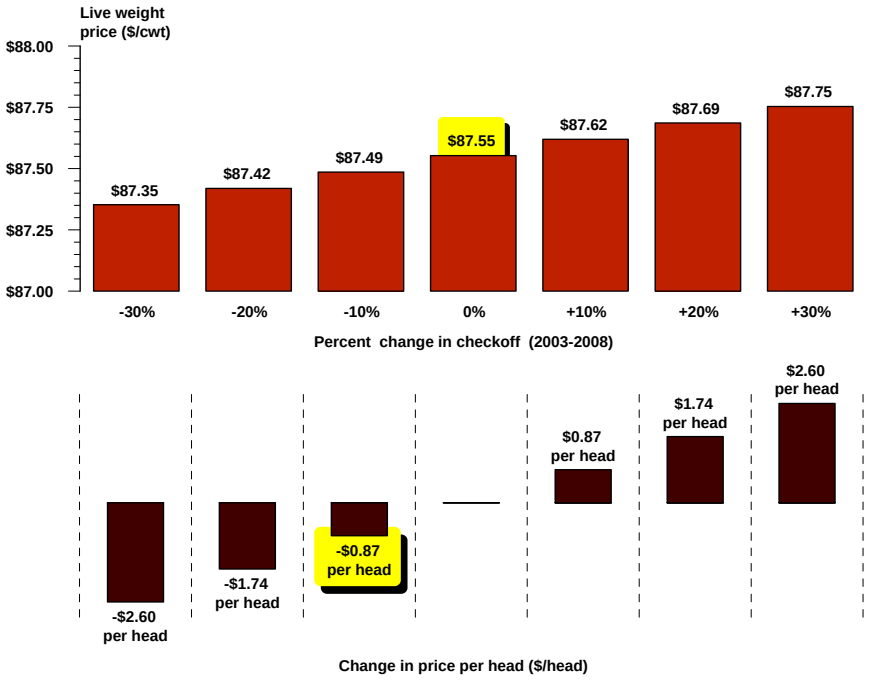


Figure 20. Estimated changes in the liveweight and per head prices with incremental changes in the checkoff dollars (2003-2008 period).

Relative Checkoff Impacts from Entry versus Servings

Embedded within the checkoff impacts on beef demand is an interesting structural change that is not readily apparent. Near the start of this report a major distinction was made about the importance of market penetration compared with the level of servings per household member. Both contribute to total demand with penetration reflecting the attraction of shoppers to buy beef and then if existing beef consumers tend to consume more or less beef in a limited period of time. If there are underlying changes in the impacts of either, then that may call for different marketing strategies by individuals and by the industry. The importance of both dimensions to demand can be shown as illustrated with Figure 21.

On the bottom axis of Figure 21 the models are identified with the ending year from which the impacts of the beef checkoff were estimated. For the first period 1987-2002, nearly 75% of the impact of the beef checkoff was due to attracting more consumers to the market compared with increasing the number of servings per household member. From that period up to 2006, the importance of market penetration declined until reaching close to 50% for the 2006 model. That is, by 2006 gains attributed to the beef checkoff were about equally attributed to entry and amount consumed. For the last two periods, the relative values remained around the 54% level resulting from attracting more consumers to buy beef. Similarly to some earlier observed changes, we know that relative changes have occurred but do not know precisely the contributing factors. It could very well be the shifts away from using television as a primary media in most of the years since 2002. Again, that is

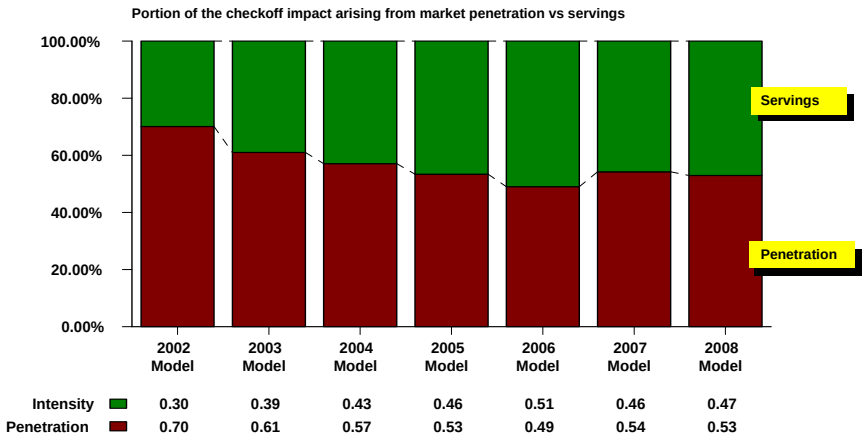


Figure 21. Relative importance of market penetration compared with the quantities of beef consumed.

conjecture and not measurable.

This section is ended noting that the generic promotions of beef do impact beef demand and the rates-of-return are robust and consistent with studies of other commodities. In the conclusion section, we will turn to several policy implications for the empirical research.

Conclusion and Implications

Commodity checkoff programs within a large number of agricultural sectors in the U.S. have become instruments for producers to have some direct influence on what is happening at the consumer level. For many years, producers lacked a legal structure for funding generic promotion activities. Even with the established enabling legislation for starting checkoff programs, most of the commodity groups dealt with legal challenges to the programs with the challenges usually centering on the constitutionality of the promotion instruments (Crespi and McEowen). The beef industry was at the forefront in dealing with the legal challenges during much of the last decade. While many of the legal issues have been settled for now, questions about the effectiveness of any program must be continually evaluated since the national programs and state orders allow mandatory assessments. If a producer must pay, then he or she must be assured that the monies are used effectively. Part of the evaluation of any program must include an overview of the administrative structure and that structure's ability to define and delivery information to the marketplace. Likewise, part of the administrative role is to determine when and if changes are needed in the organizational arrangements and mix of program areas. Equally important is the responsibility of the structure to represent all who contribute to funding the activities. There must be equity among those who benefit and who share in the costs. Also, there must be fairness in representation. Administration, delivery and equity are essential elements to the success of any program (Ward, 2006). Even with these in place, a generic program that fails to enhance the demand for the commodity is doomed. If there are no benefits to share but costs to bare, then producers rightfully have a right to challenge the program(s). Determining the ability of the beef checkoff to enhance the demand for beef and thus create benefits has been the focus of this report.

Demand is an often-used term that most everyone has a concept of even when they cannot measure it. As sovereign consumers, we make buying decisions based on our

purchasing power, prices, knowledge, and preferences. Within the food distribution systems consumers face a wide variety of choices of foods that are available, safe, identifiable, differentiated, and in many forms. Some foods are well understood and a staple part of the diet. Others are seasonal and less well understood. Some carry negative perceptions and raise health concerns. This all means that some food products are consumed frequently by most of the population while other foods may be purchased infrequently. Total demand for a food good then depends on attracting potential buyers to the product and then how much is consumed among those who purchased the product. For beef demand, this study identified and measured both components to beef demand, that is market penetration and level of use. Market penetration was calculated through the probability of becoming a beef consumer and the level of consumption determined through measuring household servings of beef. The study turned to a large database of U.S. households who reported their bi-weekly beef consumption habits. Both demographics and attitudes of the reporting households were known, thus providing direct insight into differences in beef demand across households. Using advanced statistical modeling techniques, the demand for beef was estimated.

Within a two-week shopping period nearly 78% of U.S. households include some beef in their household diet. Clearly beef is a staple part of the U.S. household menu. Likewise, a typical household member has between 3.5 and 4.0 servings of beef with the two-week time span. An at-home serving of beef is approximately .4 of a pound and this conversion links beef servings back to actual pounds of beef consumed.

While the focus of the analysis was to deal with the impact of the checkoff on demand, one cannot measure that impact in isolation of other demand drivers. The analysis addressed many demand drivers showing how changes in both market penetration and servings changed with each driver. Some demand factors such as the tendency to eat fast-foods impacted the probability of buying beef and the quantities consumed. Beef demand increases among those more prone to eat fast-foods as would be expected. A series of questions about nutrition mostly influenced the amount served but had less impact on market penetration. A major exception to this was with the question . . . *"I plan nutritious meals."* Among all demand drivers this had the greatest impact where households valuing nutritious meals were more likely to include beef in their menu. Market penetration increased from about 70% to nearly 83% across those households planning more nutritious meals. Similarly, beef servings per household member increased from 3.05 to 3.88 servings. A similar question indicating *"Important to eat regular meals"* also produced positive

responses in beef demand with both market penetration and servings showing positive changes. A series of health-related questions such as *"I am concern about cholesterol"* almost always had a negative impact on beef demand but mostly through influencing the number of servings and much less effect on market penetration.

Demographics reflect basic household differences and those differences almost always influence our consumption habits as is true for beef demand. Inclusion of beef in the diet is closely linked with age in both the likelihood of buying beef and the amount consumed. Beef demand drops exponentially with age. For household in the over-65 age range, the likelihood of buying beef drops to 74% and servings to 3.10. Demand also drops when moving from the lower to higher educated households with both penetration and servings decreasing especially among college graduates. Market penetration increases with higher income but the number of servings actually drops slightly in the $70,000 and higher income group. Beef servings decrease when the female head of the household is employed and when she is on a diet. Place of residency has a profound impact on beef consumption habits with the more rural areas showing a much higher demand for beef in the household diet. Moving from rural residency to the largest metropolitan areas leads to reductions in both frequency of buying beef and especially the number of servings.

While the demand driver impacts differ, they almost never lead to market penetrations below 70% and servings below 3.00 servings per household member. The U.S. population consumes beef across most demographics and attitudes even when the relationship is negative for a specific variable.

Is the beef checkoff a demand driver? This was the most fundamental question of the entire study and the answer is overwhelming "yes," the generic promotion of beef has shifted beef demand. All responses to the beef checkoff are shown to be statistically significant with more than a 95% confidence level. That is, the impact coefficients are statistically different from zero with more than a 95% reliability level. The beef checkoff was measured through expenditures on promotions, consumer and industry information activities, and the models were estimated over time to test for changes in the effectiveness. Estimates show that since 2002, the ability of the checkoff to attract consumers to the market has become somewhat weaker. While there is a positive link between checkoff dollars and market penetration, this dimension to the demand change has declined since 2002. Servings, while also positively linked to the checkoff, are more stable over the years since 2002 especially after 2003. Thus, for most of the years following 2002, the ability of the checkoff

dollars to attract new consumers to the market has been more challenging relative to earlier years. There is still a strong positive relationship, it is just weaker than seen in earlier estimates.

Within the text several aspects of the checkoff were highlighted with part concentrating on the impacts from two periods: 1987-2002 and 2003-2008. The data ended with December 2008. The checkoff impact was first illustrated using the extremes of actual promotions and then completely eliminating the programs. While these extremes are out of the range of the data, they do give some insight to the maximum and minimum potential impacts. For the 2003-2008 years, market penetration decreased from 78.8% to 75.8% with and without the checkoff for a three percentage point difference. Servings decreased from 3.42 to 3.31 per household member averaged across all of the other household characteristics. In the extreme, servings changed by a maximum of .11 servings in a two-week shopping period with and without the beef checkoff. For the average retail price of $4.03 during the 2003-2008 period, these shifts translate into 17 cents more in expenditures on beef per household member in a two-week period. Clearly at the retail, the impact on consumer demand for beef is registered.

Generic promotions are targeted to the end points in the distribution system and we see changes in both market penetration and at-home beef servings. There is a long-established linkage between prices and poundage at the retail and prices and volume lower down the vertical distribution system for beef. Specifically the linkage between retail, boxed-beef and liveweight have been shown in the report and appendices. That linkage has been used to take gains measured at the retail and express them to the point closest to where the checkoff assessments are collected, namely the liveweight. At this point, the models were used to show the liveweight net marginal revenue gains attributed to the beef checkoff. Net marginal revenue is the additional sales revenue that would occur with incremental changes in the checkoff programs. If that marginal gain were one, that would simply mean that a one dollar expenditure at this level would just produce one dollar in additional revenue. Values less than one point to overspending and those above one indicate gains exceeding the current expenditure levels. For the average quarterly checkoff expenditures, the models estimated for periods 1987-2002 and 2003-2008 both show rates-of-return of 5.44 and 5.55 for the two study periods. At the average the net marginal gains far exceed one, thus pointing to programs that are effectively influencing demand and creating additional gains at the liveweight level. For the years 2003-2008 the volume impact is lower

than the first years, but the value of the impact is substantially greater since the average liveweight price in 2003-2008 was $0.87 per pound compared with $0.67 for the earlier years.

For given prices, generic promotions produce positive shifts in beef demand creating additional volume gains. Once the demand relationships are known, then one can equally show how much of a price increase could occur to leave the quantity demanded at its same level before increasing the promotions. A reduction in promotions generates negative shifts in demand and for the same price the quantity purchased must decline. Then one can equally show how much of a price reduction would be required to keep consumption at the level before the reduction in promotions. This process was done to show the corresponding change in liveweight price with either increases or decreases in the checkoff expenditures. A general conclusion is that with a reasonable range of adjustments to the checkoff, for each 10% reduction in total checkoff expenditures, the liveweight price will decrease by .40% or less than ½ of a percent. This response is not linear as the range widens however. As shown in the text, a 30% reduction in the total checkoff efforts would have produced an approximate $1.00 reduction in the liveweight price. Similarly responses follow for increases in the programs.

Structurally, demand is a product of the population adjusted for market penetration times the servings among buyers. Over the years 1987-2002, approximately 70% of the demand level was attributed to the market penetration levels. By 2008, the importance of market penetration had dropped to 53% and servings increased to 47%. Structurally, it has become more difficult to attract consumers to the beef market through generic promotions relative to earlier years.

All of these analyses are based on established statistical and modeling procedures and the conclusions are strong statistically. Yet one must always recognize that the responses are statistical responses and subject to variation. That is each number has statistical variation since they are estimates from a large sample of the population. Even with the caveat, the marginal rates-of-return is large enough to provide overwhelming evidence that the programs are achieving position impacts of the U.S. demand for beef.

References

AMS. (2009) Agricultural Marketing Service. United States Department of Agriculture (AMS-USDA). Research and Promotion Program. www.ams.usda.gov/fv/rpb.html. Washington, D.C.

Beef Research And Information Act. (1985) "Beef Promotion and Research Act of 1985." (7 U.S.C. 2901-2911). Senate and House of Representatives of the United States of America. Washington D.C., Dec. 23, 1985. Pages 580-591.

Capps, Jr., O., Bessler, D.A., & Williams, G.W. (2003). "Evaluating the Economic Iimpacts Associated with Advertising Efforts of the Florida Department of Citrus." Prepared for the Advertising Review Committee in Association with the Florida Department of Citrus and Florida Citrus Mutual. College Station, TX: Forecasting and Business Analytics, LLC (FABA).

Cattlemen's Beef Promotion and Research Board. (1985) Beef Promotion and Research Act of 1985. 1985 Farm Bill. 7 U.S.C. 2901-2918. Washington D.C.

CBB. (2009) Cattlemen's Beef Board. Centennial, CO. beefboard@beefboard.org

Crespi, J. and R. McEowen. (2006) "The Constitutionality of Generic Advertising Checkoff Programs." Choices. 2nd Quarter 2006|21(2).

Chung,C., F., Bailey Norwood, and C. Ward. (2006) "Producer Support for Checkoff Programs: The Case of Beef". Choices. 2nd Quarter 2006|21(2).

Davidson, R. and J. MacKinnon. (2004) Econometric Theory and Methods. Oxford University Press. New York, NY. ISNB 0-19-512372-7. Pages 486-489.

Forker, O. and R. Ward. (1993) Commodity Advertising The Economics and Measurement of Generic Programs. Lexington Books. New York, NY. 1993.

Greene, W. (2003) Econometric Analysis. 5th Edition. Prentice Hall. Upper Saddle Rive, NJ. ISNB 0-13-066189-9. Chapter 22: Pages 780-790.

Livestock Meat Information Center. (2009) Price and Production Data. Lakewood, CO.

Long, J. Scott. (1997) Regression Models for Categorical and Limited Dependent Variables. Sage Publications. Advanced Quantitative Techniques in the Social Series Vol. 7. Thousand Oaks, CA. ISBN 0-8039-7374-8.

NASS-USDA. (2009) "Cattle National Statistics." National Agricultural Statisticsa Service. United State Department of Agriculture. www.nass.usda.gov/QuickStats/

NCBA. (2009) National Cattlemen's Beef Association. Centennial, CO. www.beef.org

NPD Group. (2009) Beef Serving Database. National Panel Diary. Chicago, IL. 2009.

TSP International. (2009) Reference Manual for TSP 4.5. Palo Alto, CA.

Ward, R. (2006) "Commodity Checkoff Programs and Generic Advertising." Choices. 2nd Quarter 2006|21(2).

Ward, R. (2004). "Beef Demand and the Rate-Of-Return to the U.S. Beef Checkoff: Two Independent Evaluation Approaches." Evaluation Report to the Cattlemen's Beef Promotion and Research Board (59 pp). Centennial, CO.

Ward, Ronald W., W. Moon, S. Medina. (2002) "Measuring the Impact of Generic Promotions of U.S. Beef: An Application of Double-Hurdle and Time Series Models." International Food and Agribusiness Management Review. 4(4)2002. : Pp. 361-371

Ward, R. (2004). "Beef Demand and the Rate-Of-Return to the U.S. Beef Checkoff: Two Independent Evaluation Approaches." Evaluation Report to the Cattlemen's Beef Promotion and Research Board (59 pp). Centennial, CO.

Appendix A: NPD Household Servings Diary Questions

DEMOGRPAHICS

1. IDD = HOUSEHOLD ID
2. WAVE = NPD WAVE NUMBER (Waves 1198-1496…March'03-Nov'08)
3. DMHSZ = DEMOGRAPHIC HOUSE HOLD SIZE
   (1=1 MEMBER; 2=2 MEMBERS ; 3 =3-4 MEMBERS; 4=5+ MEMBERS)
4. DMMSZ = MARKET SIZE
   (1=1 MIL+; 2=500-999 MIL;3=250-499 MIL;4=50-249 MIL;5=RURAL)
5. DMCHL = CHILDREN UNDER 18 YEARS *(1=YES; 2=NO)*
6. DMFEM = EMPLOYMENT OF FEMALE HEAD *(1=EMPLOYED;2=NOT EMPLOYED)*
7. DMAGE = AGE OF FEMALE HEAD *(1=<35; 2=35-44; 3=45-54; 4=55-64; 5=65+)*
8. DMEDU = EDUCATION OF FEMALE HEAD
   (1=NO HIGH SCHOOL;2=HIGH SCHOOL;3=SOME COLLEGE; 4=COLLEGE GRADUATE)
9. DMREG = CENSUS REGION
   (1=NEW ENGLAND; 2=MIDDLE ATLANTIC; 3=EAST NORTH CENTRAL; 4=WEST NORTH CENTRAL; 5=SOUTH ATLANTIC; 6=EAST SOUTH CENTRAL; 7=WEST SOUTH CENTRAL; 8=MOUNTAIN; 9=PACIFIC)
10. DMINC = 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+)
11. DTCHL = # OF CHILDREN IN HH ON A DIET
12. DTMAL = # OF ADULT MALES IN HH ON A DIET
13. DTFEM = # OF ADULT FEMALES IN HH ON A DIET
14. CNBEF = NUMBER OF HOUSEHOLD EATINGS IN 2 WEEKS - BEEF

ORIGINAL ATTITUDINAL SURVEY SINCE 1984

(1=COMPLETELY AGREE; 2=AGREE MOSTLY; 3=AGREE SOMEWHAT; 4=NEITHER AGREE OR DISAGREE; 5=DISAGREE SOMEWHAT; 6=DISAGREE MOSTLY)

15. ATSNK = AVOID SNACKING ENTIRELY
16. ATFRY = AVOID FRIED FOOD
17. ATFOR = TRY FOREIGN FOOD
18. ATBAK = LIKE TO BAKE FREQUENTLY
19. ATLAB = CHECK LABELS FOR HARMFUL INGREDIENTS
20. ATDOC = DOCTORS GIVES ADVICE ON DIET
21. ATREG = IMPORTANCE TO EAT REGULAR MEALS
22. ATWGT = OVERWEIGHT ISN'T ATTRACTIVE
23. ATSWM = LOVE TO SWIM
24. ATCAL = CONSCIOUS OF CALORIES
25. ATLBS = LIKE TO LOSE 20 POUNDS

Appendix A: continued

FOOD AND BEVERAGE HABITS (NPD)

(1=ALWAYS ENCOURAGE; 2=ALMOST ALWAYS ENCOURAGE; 3=SOMETIMES ENCOURAGE; 4=NEITHER; 5=SOMETIMES DISCOURAGE; 6=ALMOST ALWAYS DISCOURAGE)

26. FDHOT = HOT DOG SANDWICH
27. FDCER = GRANOLA CEREAL
27. FDBER = BEER
28. FDWIN = WINE
29. FDMLK = WHOLE MILK
30. FDBRD = WHITE BREAD
31. FDRIC = RICE
32. FDSKM = SKIM-LOW FAT MILK
33. FDMAR = MARGARINE
34. FDCOF = CAFFEINATED COFFEE
35. FDSWT = PRE SWEETENED CEREAL
36. FDTUR = TURKEY
37. FDPIZ = PIZZA
38. FDLUN = LUNCHMEAT
39. FDFFR = FRENCH FRIES
40. FDTAC = TACOS
41. FDFCH = FRIED CHICKEN

NUTRITIONAL QUESTIONS - AGREE OR DISAGREE

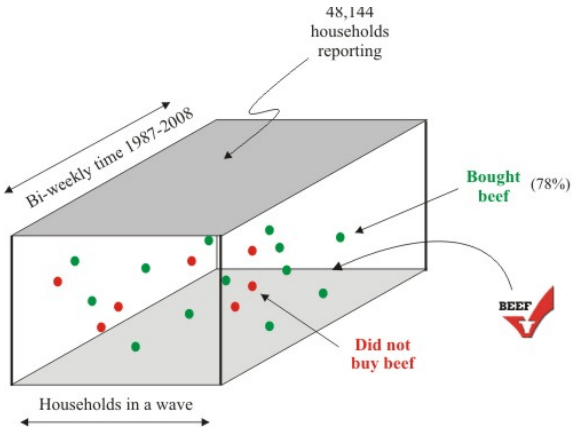
(1=COMPLETELY AGREE; 2=AGREE MOSTLY; 3=AGREE SOMEWHAT; 4=NEITHER AGREE OR DISAGREE; 5=DISAGREE SOMEWHAT; 6=DISAGREE MOSTLY)

41. NTKNO = KNOW MORE THAN MOST
42. NTPLN = PLAN NUTRITIOUS MEALS
43. NTCHS = CHILDREN SHOULD NOT EAT SWEETS
44. NTVIT = VITAMINS RECOMMENDED BY PHYSICIAN
45. NTING = FOOD SHOULD HAVE BODY BUILDING INGREDIENTS
46. NTFRU = ALWAYS KEEP SOME FRUIT AROUND
47. NTSUG = A PERSON SHOULD BE CAUTIOUS ABOUT - SUGAR
48. NTCHL = A PERSON SHOULD BE CAUTIOUS ABOUT - CHOLESTEROL
49. NTADD = A PERSON SHOULD BE CAUTIOUS ABOUT - ADDITIVES
50. NTFAT = A PERSON SHOULD BE CAUTIOUS ABOUT - FATS
51. NTSAL = A PERSON SHOULD BE CAUTIOUS ABOUT - SALT
52. NTPRE = A PERSON SHOULD BE CAUTIOUS ABOUT - PRESERVATIVES
53. NTCAF = A PERSON SHOULD BE CAUTIOUS ABOUT - CAFFEINE
54. NTFRS = IMPORTANT FOR FOOD TO BE FRESH
55. NTCAN = DEPEND MOSTLY ON CAN FOOD
56. NTLOK = MOST IMPORTANT FOOD LOOKS, SMELLS, TASTES GOOD
57. NTBRN = BEST KNOWN BRANDS ARE HIGHEST QUALITY
58. NTTAS = EVERYTHING GOOD FOR YOU DOESN'T TASTE GOOD

Appendix B: Supporting Statistics for Tables 1 and 2

Market penetration (probit models) and beef servings models were estimated are reported in Tables 1 and 2. For the full data period a total of 48,144 observations were used with a few observations deleted when a particular variable value was missing. Graphically the concept is as shown below. Households may report over many waves and the full data set of households reporting extends from January 1987 through December 2008. In the figure the red dots are household who did not buy beef and the green dots reflect buyers. For each of the 48,144 dots (households) we know the demographics, buying behavior, attitudes, and concerns as outlined in the text. Probit model as estimated across all dots and then give us the probability of buying beef (see Table 1). The servings model is over the green dots or those who did buy some beef in a two-shopping occasion. The dots move around over time and differ depending on each household's characteristics. The probit models show the probability of buying beef (green dots) then the servings model shows the number of servings or green dot size. Prices, demographics, attitudes, concerns, and promotions potentially influence this probability. These same variables or demand drivers may also influence the amount served (size of the green dot). Table 2 reports the servings model showing the impacts of major demand drivers on the number of servings per household member within a two-week period. The basic empirical question is the influence of the checkoff on the household decisions.

In Tables 1 and 2 the health concern and price variables were expressed with PC1 and PC2 for health and PR1 and PR2 for the price. Health included concerns about fats, cholesterol, additives, and preservatives. Price include beef, pork, and poultry. As would be expected the variables within each category were correlated. High correlations can reduce the reliable of the estimates, even those not within the correlated groups. A method of principal components if used to deal with the correlation problem. While the method is well established part of modeling, it is too details for this report. However, for the interested reader needing more empirical detail about PC and PR from Tables 1 and 2, the loading factors for the principal component procedures are reported on the next page (TSP).



Appendix B: continued

Health concerns principal components for Tables 1 and 2.

Health Variables	PC1 Loading Factors	PC2 Loading Factors
Concern about		
Fats	0.88895	0.32430
Cholesterol	0.87515	0.38060
Additives	0.90969	-0.29225
Preservatives	0.87809	-0.40487

Name		Eigenvalue	Cumulative R-Squared
1	PC1	3.1547	0.788
2	PC2	0.4993	0.913
3	PC3	0.1946	0.962
4	PC4	0.1512	1.000

* All variables were standardized before calculating the loading factors.

Price variable principal components for Tables 1 and 2.

Price Variables	PR1 Loading Factors	PR2 Loading Factors
Beef Prices	0.8888	0.4458
Poultry Prices	0.9146	-0.3609
Pork Prices	0.9600	-0.0689

Name		Eigenvalue	Cumulative R-Squared
1	PC1	2.5481	0.849
2	PC2	0.3338	0.961
3	PC3	0.1179	1.000

* All variables were standardized before calculating the loading factors.

Appendix C: Checkoff Coefficients Across Time

Market penetration and beef servings models were first estimated as presented in Tables 1 and 2. Subsequently, the same models were estimated while changing the ending year of the database starting with 1987-2002 period. The period of this process was to determine if the effectiveness of the checkoff had changed following the initial period. All of the model coefficients were estimated but only the changes in the checkoff coefficients were used in the evaluation section. Hence, below we are showing those coefficients for each period along with the standardized values (see Figure 15). Note that for every period the coefficients are statistically significant (Ward, 2004; Long).

Beef checkoff coefficients estimated across time periods (see Tables 1 and 2 for the models).

Periods	Checkoff Coefficient	t-values	Standardized Coefficients
Market Penetration Model			
1987-2002	2.51698	3.79851	4.34615
1987-2003	1.89515	3.06195	3.03258
1987-2004	1.83446	3.06252	2.81743
1987-2005	1.78711	3.00869	2.70421
1987-2006	1.53548	2.61575	2.28390
1987-2007	1.68247	2.92323	2.44355
1987-2008	1.67333	2.92511	2.40292
Beef Servings Model			
1987-2002	2.48014	1.90274	1.24518
1987-2003	2.26308	1.90145	1.04393
1987-2004	2.50664	2.18331	1.12237
1987-2005	2.71339	2.38639	1.20367
1987-2006	2.64674	2.37575	1.15204
1987-2007	2.56797	2.33621	1.10662
1987-2008	2.68051	2.45088	1.15257

* The coefficients for 1987-2008 are identical to those in Tables 1 and 2.

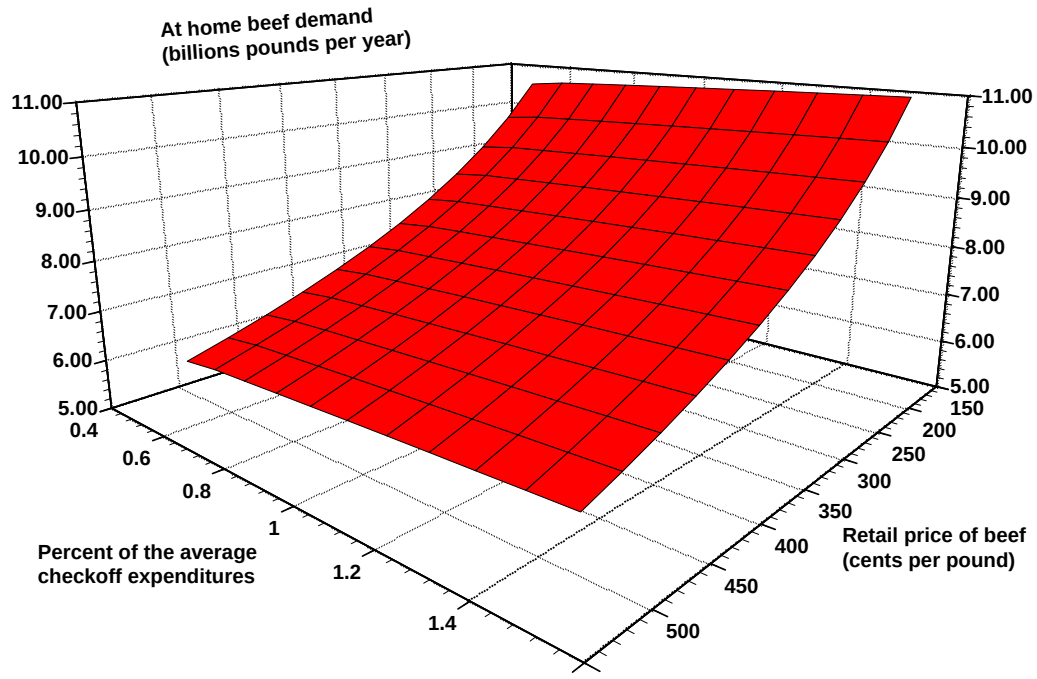
Appendix D: Simulation Methods

The table below shows the total household reports and the demand drivers (X_{jk}). Each X is either the actual variable values or set to a controlled level. Then for those values and the estimated models, the probability of buying beef and the level of beef servings are estimated for those demand driver values for each household. For example, suppose the last variable (X_{jn}) is the checkoff expenditures. The simulation could first predict market penetration and servings for the actual checkoff dollars along with all of the other variables. Next set the last variable to zero (no checkoff) and then predict market penetration and servings, again with all of the other variables taking their actual values for each household. Finally, average the penetration and servings over the households for each set of controlled conditions. Differences in the averages over values of the controlled variable is then the effects of this variable for the average household (Long, p. 130).

	Demand Drivers	Market Penetration	Probability of Buying	Beef Servings	Periods
H o u s e h o l d s	X_{11} .... X_{1k} X_{21} .... X_{2k} :	$\check{D}_1$ $\check{D}_2$:	$Prob_1$ $Prob_2$:	$\hat{Y}_1$ $\hat{Y}_2$:	1987-2002
	X_{j1} .... X_{jk} :	$\check{D}_j$:	$Prob_j$:	$\hat{Y}_j$:	1987-2003
	X_{j1} .... X_{jk} :	$\check{D}_j$:	$Prob_j$:	$\hat{Y}_j$:	1987-2004
	X_{j1} .... X_{jk} :	$\check{D}_j$:	$Prob_j$:	$\hat{Y}_j$:	1987-2005
	X_{j1} .... X_{jk} :	$\check{D}_j$:	$Prob_j$:	$\hat{Y}_j$:	1987-2006
	X_{j1} .... X_{jk} :	$\check{D}_j$:	$Prob_j$:	$\hat{Y}_j$:	1987-2007
	X_{j1} .... X_{jk} : X_{n1} .... X_{nk}	$\check{D}_j$: $\check{D}_n$	$Prob_j$: $Prob_n$	$\hat{Y}_j$: $\hat{Y}_n$	1987-2008
		$\overline{D} = \sum \check{D}_j$	$\overline{Prob} = \sum Prob_j$	$\overline{Y} = \sum \hat{Y}_j$	

Appendix E: Demand Surface

The figure below reflects the retail at-home demand for beef across retail prices and checkoff levels. Quantities are in terms of billions of at-home retail pounds in an average year. Checkoff dollars are indexed relative to the mean with 1.0 being the average checkoff dollars. Prices are ranged in term of cents per retail pounds of beef. The drop in demand with higher prices is most evident. Households respond to changing beef prices. A much smaller respond to increased checkoff efforts is seen with the slow but positive gain as promotions increase. This demand surface is based on the average household aggregated to the population. For specific attributes the surface would rise or fall depending on the household characteristics and the number of households fitting into that set of attributes. For study purposes, the model and this surface provides a way to address questions about beef demand when underlying household condition change. Movement along the promotion axis implies certain checkoff elasticities and movement along the price axis leads to price elasticities. The price elasticities are in the range of -.52 depending on the point on the surface.



Dr. Ronald W. Ward
Professor Emeritus
1125 McCarty Hall
Food and Resource Economics Department
University of Florida
Gainesville, FL 32611
rward@ufl.edu
June 15, 2009