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AN ECONOMIC ANALYSIS OF NATIONAL BEEF CHECKOFF DEMAND-DRIVING ACTIVITIES

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Full Report & Appendices

This study was commissioned by the Checkoff Evaluation Committee.

The Beef Checkoff program was implemented in 1986 as part of the 1985 Farm Bill and is designed to increase the overall demand (both domestic and foreign) for U.S. beef products. The Beef Checkoff program assesses $1 per head on the sale of live domestic and imported cattle, in addition to a comparable assessment on imported beef and beef products. States may retain up to 50 cents of the dollar and forward the other 50 cents to the Cattlemen's Beef Promotion and Research Board, commonly referred to as the Cattlemen's Beef Board (CBB), which administers the national Beef Checkoff program.

Under existing agricultural legislation, the United States Department of Agriculture (USDA) is responsible for the implementation and oversight of commodity, promotion, and consumer information programs, commonly known as "checkoff" programs. As part of their oversight, USDA's Agricultural Marketing Service (AMS) requires commodity boards to conduct an independent evaluation of the effectiveness of their programs every five years. Accordingly, the purpose of the research reported here is to conduct such an economic evaluation for the most recent 5-year period, 2019-2023, to assess the impacts of the national Beef Checkoff program on building demand for beef domestically and internationally.

Objective and Scope

The overall goal of this research is to provide a retrospective analysis on the impact and effectiveness of national Beef Checkoff demand-driving activities for the most recent 5-year period, 2019-2023. To assess the efficacy of the national Beef Checkoff in achieving its mission, this study addressed the following objectives:

1. To measure whether national Beef Checkoff demand-driving activities increased demand of beef products (domestic and abroad) compared to what would have occurred in the absence of these activities.
2. To measure the combined benefits of national Beef Checkoff demand-driving activities in terms of their incremental financial impact to beef producers and importers, and then compare these benefits with the costs of the program to calculate an overall return on investment (ROI) of the national Beef Checkoff program.
3. To measure the indirect benefits of national Beef Checkoff demand-driving activities to the broader macroeconomy.

For this study, the impacts of all drivers/factors affecting domestic demand, domestic supply, and import beef demand, for which data were available, were measured statistically using econometric models. This framework enabled the study to account for the effects of significant demand drivers/factors, beyond the national Beef Checkoff's primary categories[1], that influence beef demand and supply over time. To estimate the incremental financial impact of the national Beef Checkoff, in terms of industry returns and additional benefits, a market simulation model was used to calculate an average ROI for the national Beef Checkoff. An average ROI measures

[1] For this study, the national Beef Checkoff's demand-driving activities were classified into one of nine primary categories, which are described in the next section of this report.

the increase in beef industry (producers and importers) returns for each $1 invested in national Beef Checkoff demand-driving activities. Finally, the broader macroeconomic impact of the national Beef Checkoff on employment, gross domestic product (GDP), and tax revenue creation were estimated using a macroeconomic input-output model.

This independent evaluation was carried out by Dr. Harry M. Kaiser who is the Gellert Family Professor of Applied Economics and Management at Cornell University in the Charles H. Dyson School. Dr. Kaiser has been involved in the research of commodity promotion for 40 years and is one of (if not) the leading experts on this topic in the world. He has written 150 refereed journal articles, five books, 17 book chapters, and over 150 research bulletins. Dr. Kaiser has conducted over 130 economic evaluation studies of domestic and international checkoff programs in the United States, Canada, and Europe on such commodities as fluid milk, cheese, butter, salmon, peanuts, red meat, pork, raisins, walnuts, blueberries, potatoes, beef, wheat, watermelons, high-valued-agricultural commodities, and bulk agricultural commodities. In 2014 and 2019, Dr. Kaiser conducted the economic evaluation study for the national Beef Checkoff program and published his findings in numerous trade publications as well as in the academic journal *Applied Economics*.[2] In 2005, Kaiser was the lead author of a book on all commodity checkoff programs in California. In 2006, 2010, and 2015, Dr. Kaiser was a principal (or co-principal) investigator on three comprehensive economic studies investigating the overall benefits and costs of all FAS programs to cooperators and the general economy. Dr. Kaiser received the Distinguished Member Award from the Northeastern Association of Agricultural and Resource Economics in 2002 and then again in 2009. In 2006, Dr. Kaiser received the highest award given to alumni of the University of Wisconsin-Eau Claire—the Alumni Distinguished Achievement Award. In 2009, Dr. Kaiser received the Outstanding Achievement Award from the Board of Regents of the University of Minnesota, which is the highest award conferred by the university to an alumnus. Dr. Kaiser received the Outstanding Alumni Award from the Department of Applied Economics, University of Minnesota, in 2009. In 2017, he was elected a Fellow of the Agricultural and Applied Economics Association.

[2] Kaiser, Harry M. "An Economic Analysis of the Cattlemen's Beef Promotion and Research Board Demand-Enhancing Programs." *Applied Economics*. 48(2016):312-320.

National Beef Checkoff Program Expenditures by Primary Category

The national Beef Checkoff program was implemented in 1986 as part of the 1985 Farm Bill and is designed to increase the overall demand for U.S. beef products (domestic and abroad). As the administer, the CBB invests national Beef Checkoff program dollars in a variety of demand-driving activities to accomplish its overall objective of stimulating demand for U.S. beef. For the most recent 5-year period, 2019-2023, the national Beef Checkoff expended an average of $40.3 million program dollars[3] per year on its demand-driving activities. For this study, these demand-driving activities were classified into one of the following primary categories (referred to as primary categories *or* national primary categories throughout the report):

1. Generic beef advertising
2. Public relations
3. Beef safety research
4. Channels marketing
5. Industry information
6. New product development
7. Product enhancement research
8. Nutritional research
9. Foreign market development

Figure 1 presents the total national Beef Checkoff program budget for these nine primary categories over the time-period 2006-2023. In 2006, these national primary categories totaled $41.4 million and by 2023 totaled $39.4 million.

Figure 2 illustrates the percentage of the 2023 national Beef Checkoff program budget spent on each of the national primary categories. In 2023, generic beef advertising and foreign market development expenditures were the largest categories of the national Beef Checkoff program budget, each accounting for 21% of the spending. This was followed by public relations (16%) and channels marketing (16%). National Beef Checkoff expenditures for industry information represented 9% of the 2023 program budget, while nutritional research and new product development each comprised 5%. The remaining categories receiving the smallest percentage of the 2023 national Beef Checkoff program budget included beef safety research (4%) and product enhancement research (3%).

Figure 3 displays annual generic beef advertising expenditures as a percentage of the total national Beef Checkoff program budget from 2006-2023. These expenditures were devoted to domestic advertising methods such as print, online, radio, broadcast, outdoor, and social media. Similar to other checkoff commodity programs, the national Beef Checkoff decreased its reliance on generic advertising from 2006 to 2016. However, since 2016, there has been a general increasing trend in advertising investments from 20% (2016) to 30% (2022) and 22% (2023). Today, generic beef advertising continues to be an important category for the national Beef Checkoff.

[3] In addition to national Beef Checkoff program funds, yearly budget totals across the nine primary categories include contractor-acquired contributions and government (USDA/FAS) monies that are expended on demand-driving activities in the foreign market development category, which are referred to as "other foreign marketing expenditures" throughout the report.

Figure 1. National Beef Checkoff Program Funds Expended on Primary Categories from 2006-2023

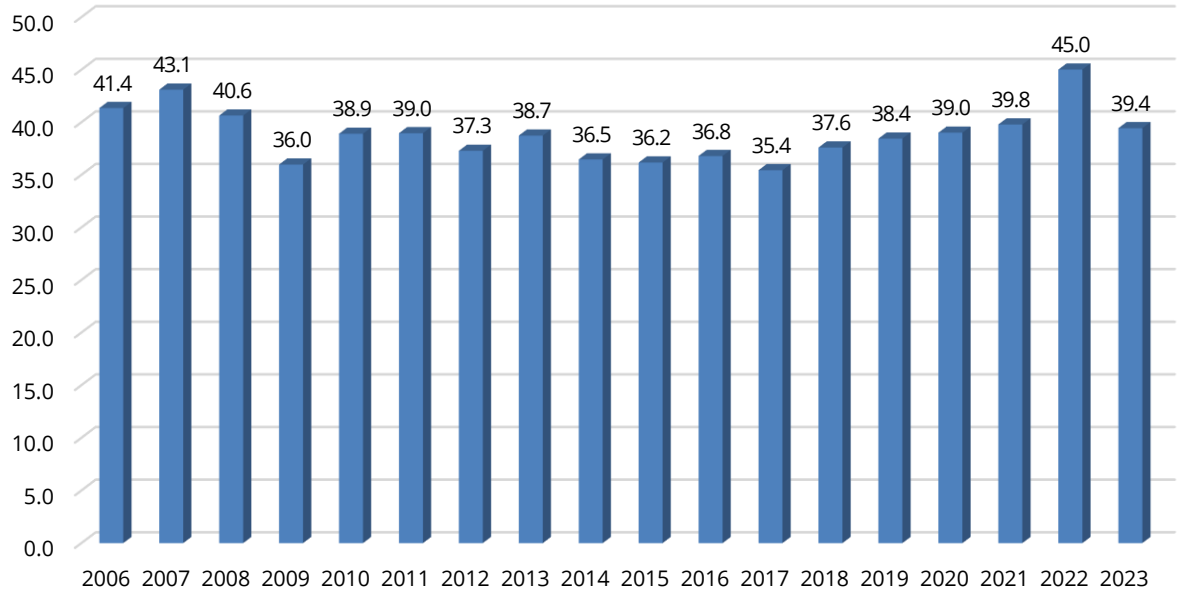


Figure 2. Percentage of National Beef Checkoff Program Funds[a] Expended on Each Primary Category in 2023

[a] The percentage of funds expended on demand-driving activities in the foreign market development category include national Beef Checkoff program funds along with contractor-acquired contributions and government (USDA/FAS) monies.

Figure 3. Generic Beef Advertising
Percentage of National Beef Checkoff Funds Expended from 2006-2023

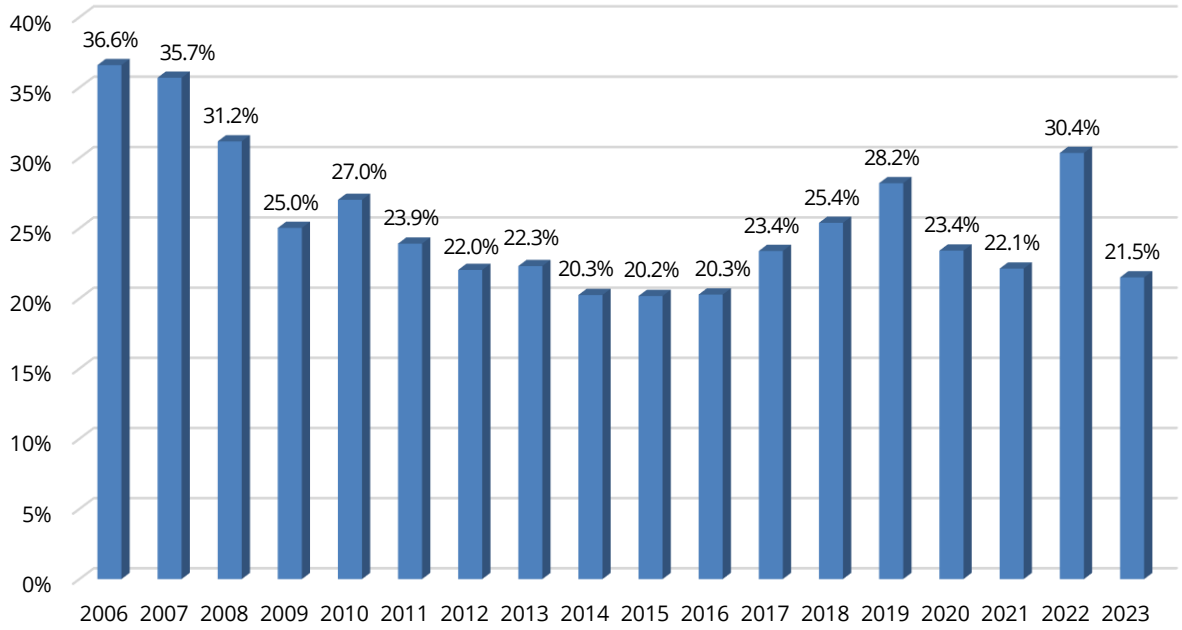
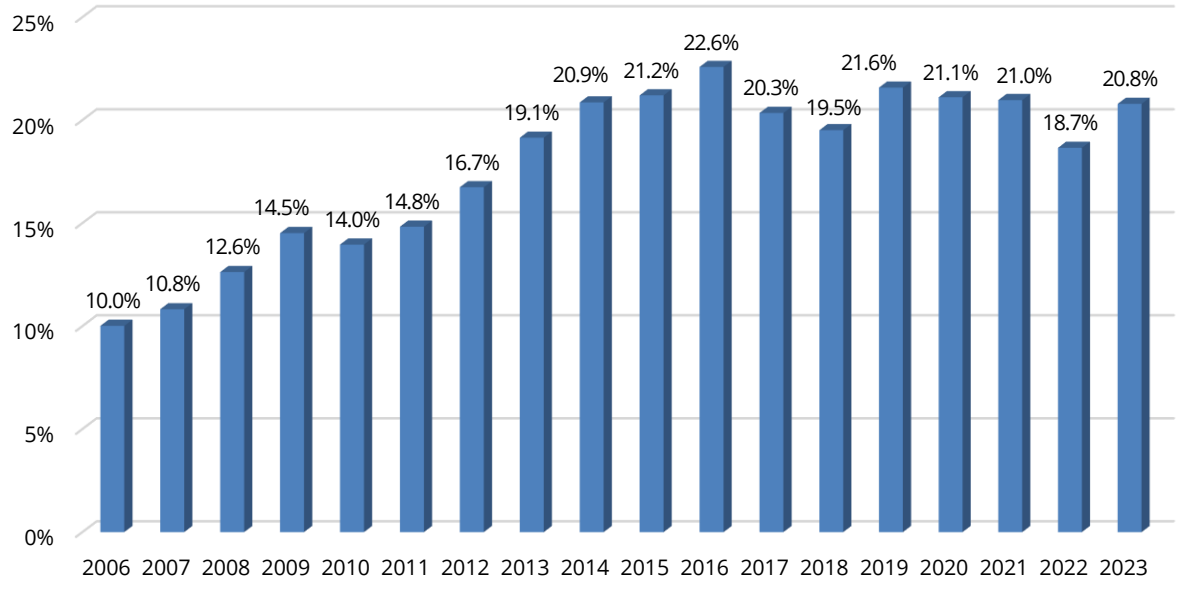


Figure 4. Foreign Market Development
Percentage of National Beef Checkoff Funds[a] Expended from 2006-2023



[a] In addition to national Beef Checkoff program funds, yearly budget totals across the nine primary categories include contractor-acquired contributions and government (USDA/FAS) monies that are expended on demand-driving activities in the foreign market development category.

Figure 4 presents national Beef Checkoff program funds (and other foreign marketing expenditures) that were expended on demand-driving activities in the foreign market development category to stimulate import demand for U.S. beef products in target international markets. In-market activities that are implemented to develop new markets and expand existing ones include promotion, trade services, technical assistance, and education on proper handling, cooking, and merchandising techniques. In 2023, these efforts contributed to U.S. beef exports in the amount of 3.2 billion pounds, which represents 11.7% of domestic commercial beef disappearance. From 2006-2016, the amount of national Beef Checkoff program funds (and other foreign marketing expenditures) spent on demand-driving activities in target foreign markets gradually increased. Since 2016, the amount of national Beef Checkoff program funds (and other foreign marketing expenditures) spent on foreign market development has remained steady at around 20% to 21%.

Figure 5 shows expenditures on channels marketing as a percent of the national Beef Checkoff program budget from 2006-2023. This category includes activities that support beef promotion and marketing in the retail and foodservice sectors. As illustrated in the graph, expenditures in this category have declined over time. In 2009, the national Beef Checkoff invested 23% of its program budget in channels marketing, and by 2023 this had declined to 16%. Even though channels marketing expenditures have declined over the years, it is still an integral category for the national Beef Checkoff.

One primary category that has seen a substantial increase in national Beef Checkoff program funding is industry information. This category includes activities that focus on sharing information with consumers on industry specific topics such as animal care and handling, production technology, beef advocacy, and issues and crisis management. As illustrated in Figure 6, in 2006, the national Beef Checkoff spent just 3% of its program budget on industry information and by 2023 this category almost tripled to 9% of the total program budget.

Another primary category that has increased its share of national Beef Checkoff program funds is nutritional research, which is shown in Figure 7. Nutritional research includes research projects that focus on beef's role in human nutrition. Nutritional research was only 2% of the program budget in 2006 but has since grown to 5% in 2023.

Figure 8 shows national Beef Checkoff expenditures on new product development as a percent of the total program budget from 2006-2023. This category consists of activities that bring new and relevant culinary techniques, recipes, and cookery applications to end users (e.g., retail, foodservice, and direct to consumer marketing channels) for existing and newly identified beef cuts. Expenditures in this category reached a high of 7% in 2013 but have since held steady between 5% and 6% of the national Beef Checkoff program budget.

Figure 5. Channels Marketing
Percentage of National Beef Checkoff Funds Expended from 2006-2023

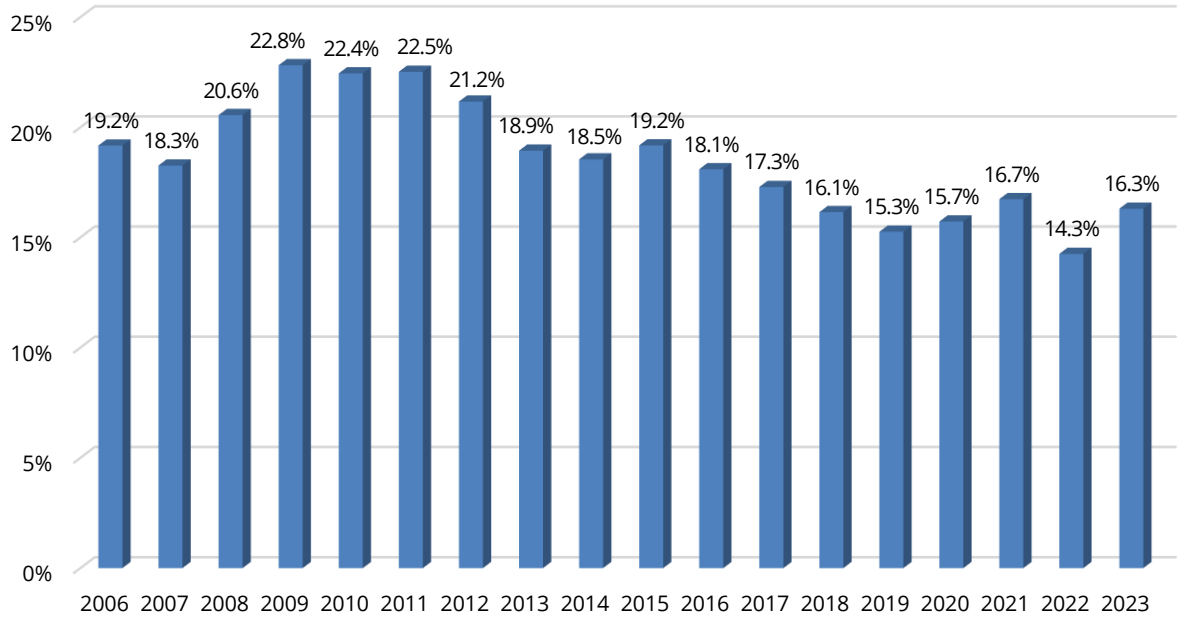


Figure 6. Industry information
Percentage of National Beef Checkoff Funds Expended from 2006-2023

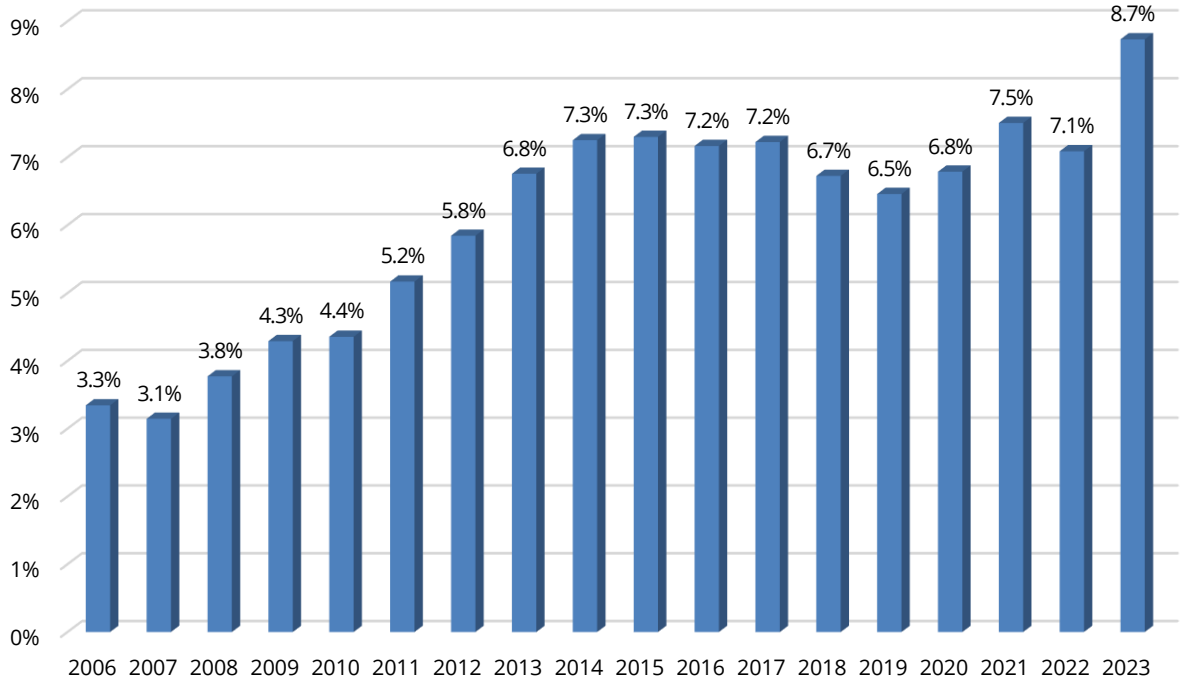


Figure 7. Nutritional Research
Percentage of National Beef Checkoff Funds Expended from 2006-2023

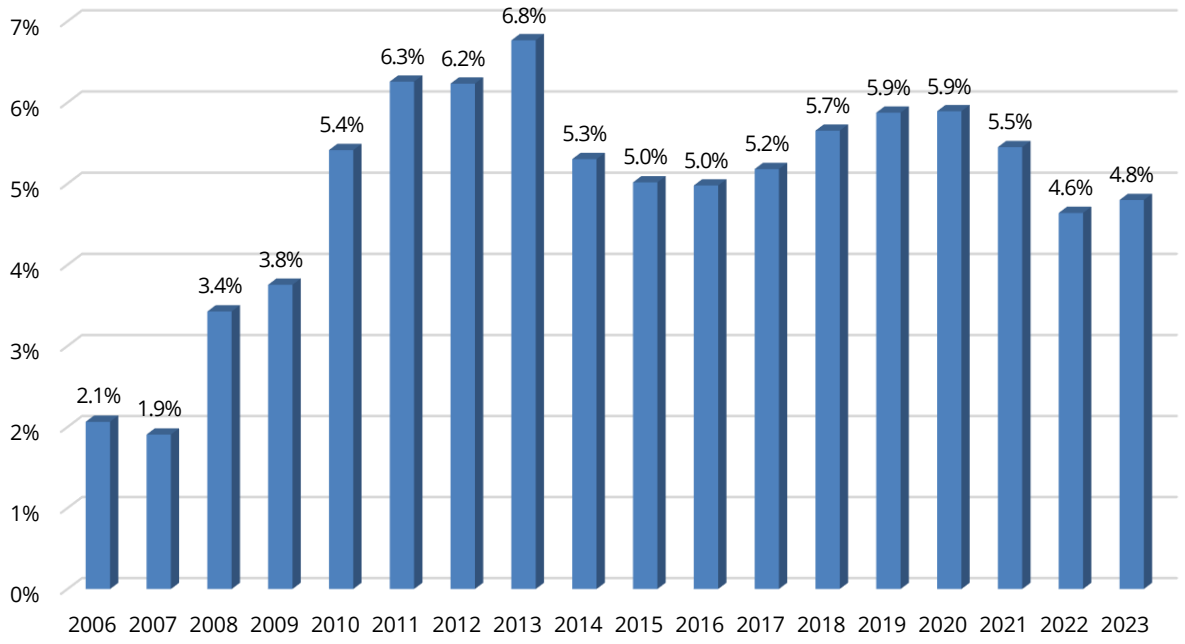


Figure 8. New Product Development
Percentage of National Beef Checkoff Funds Expended from 2006-2023

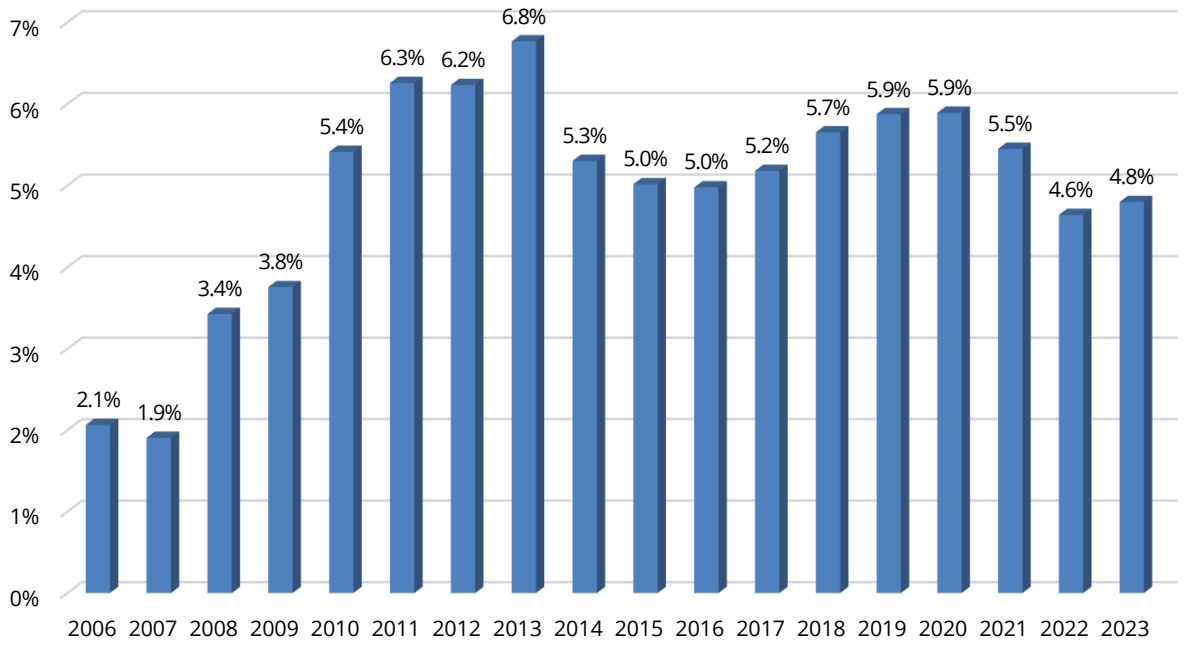


Figure 9. Beef Safety Research
Percentage of National Beef Checkoff Funds Expended from 2006-2023

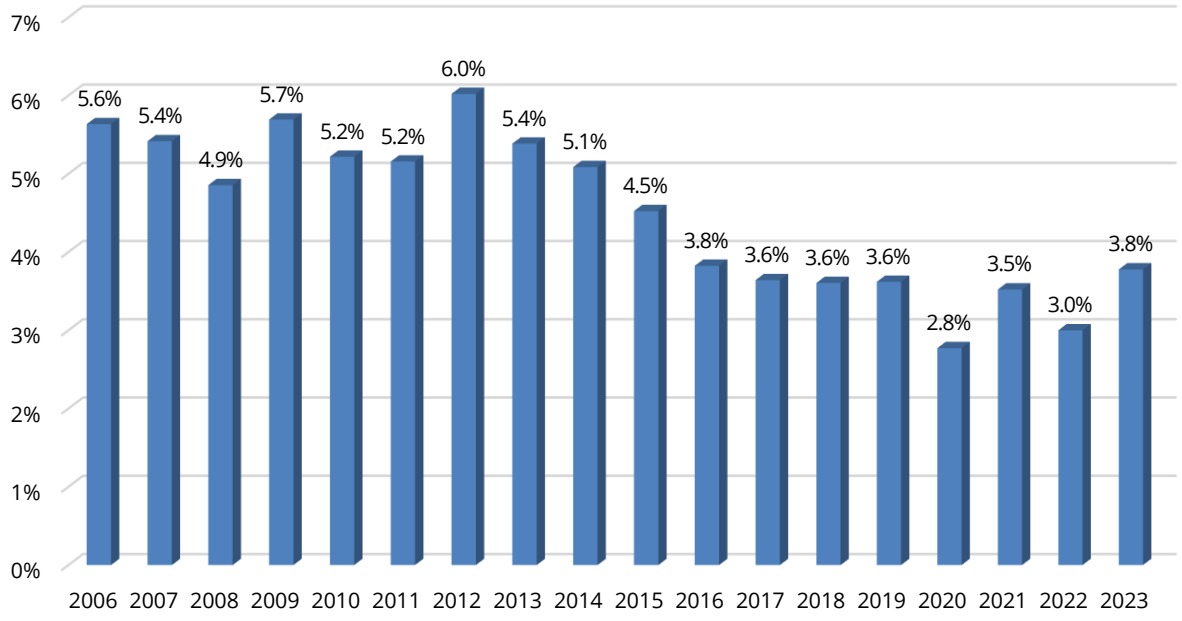


Figure 10. Product Enhancement Research
Percentage of National Beef Checkoff Funds Expended from 2006-2023

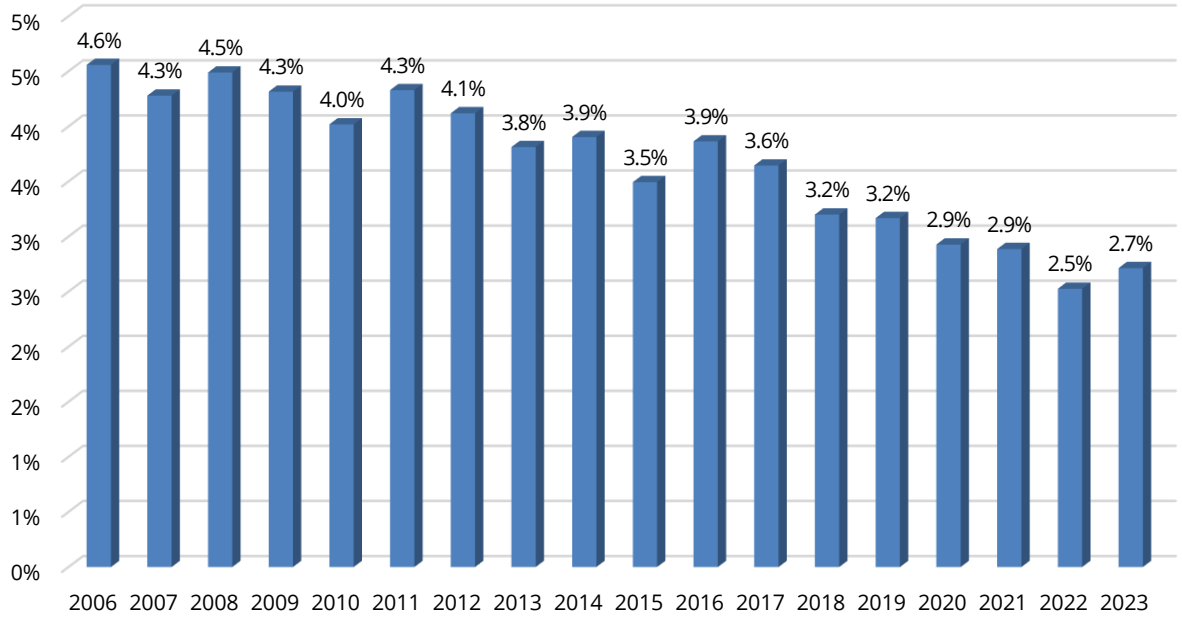
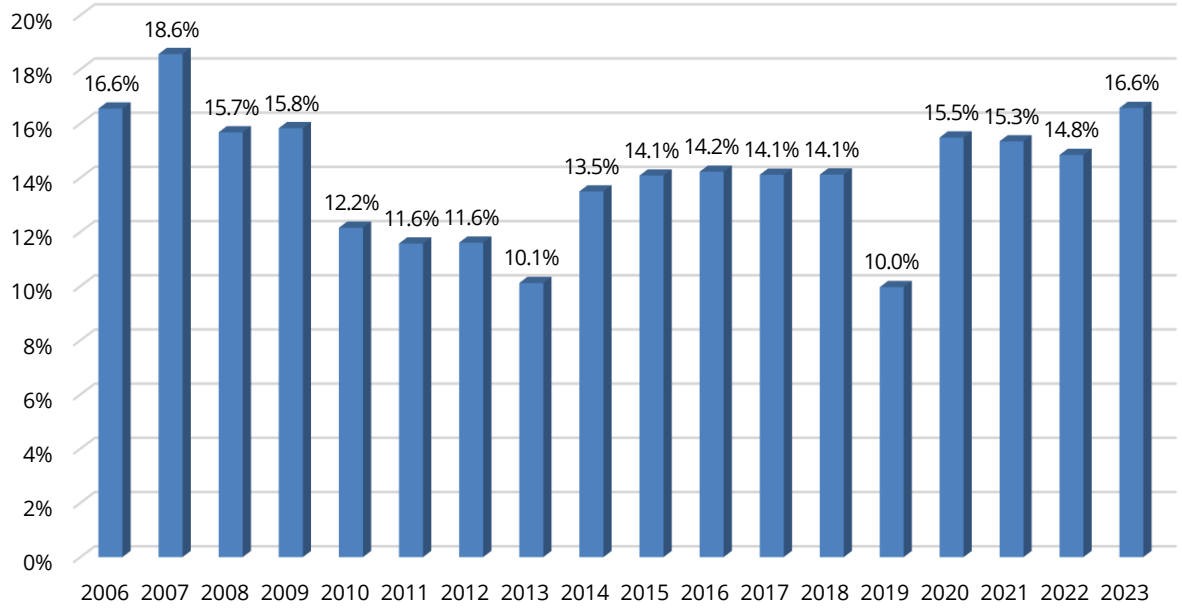


Figure 9 shows national Beef Checkoff expenditures on beef safety research as a percent of the total program budget. This category of spending includes research projects that focus on pre- and post-harvest safety protocols for beef and beef products. Since 2006, national Beef Checkoff expenditures on beef safety research have declined from 6% (2006) to 4% (2023) of the total program budget.

Figure 10 shows national Beef Checkoff expenditures on product enhancement research as a percent of the total program budget. This category includes projects focused on product quality and enhancement to include muscle profiling (e.g., identifying new cuts within undervalued areas of the carcass such as the flat iron steak), tenderness, shelf-life, etc. This category has steadily declined over time. In 2006, the national Beef Checkoff devoted 5% of its program budget to this category, and in 2023 devoted 3%.

Figure 11 presents national Beef Checkoff expenditures on public relations as a percent of the total program budget. At its core, public relations is about influencing, engaging, and building strong relationships with key stakeholders, which is why it is one of the most commonly used marketing strategies among checkoff programs and other firms in the U.S. For the national Beef Checkoff, the public relations category includes demand-driving activities that proactively share positive beef messages with consumers through channels such as earned and paid media outlets, strategic partnerships, and satellite media tours. Expenditures in this category have slightly declined over time from 17% in 2006 to 10% in 2013. However, since 2013, the national Beef Checkoff has devoted a fairly consistent share of its program budget to this category reaching 17% in 2023.

Figure 11. Public Relations
Percentage of National Beef Checkoff Funds Expended from 2006-2023



Data Limitations

This analysis was based on secondary data from government sources, private venders, CBB, and the U.S. Meat Export Federation (USMEF). The accuracy of the results was dependent on the quality of this secondary data, the bulk of which mainly measured beef demand (domestic and export) and the drivers/factors impacting the demand for beef and beef products. Although these datasets were deemed the most reliable for this economic evaluation, it is recognized that large data sets are not 100% accurate regardless of the source.

For this study, numerous drivers/factors that impact both the demand and supply of beef were considered. To quantify the impact of the study's focal factor (national Beef Checkoff demand-driving activities), the statistical models developed used all available secondary data sources to control the other drivers/factors included in the analysis. However, it is almost certainly true that not all demand and supply drivers/factors were accounted for in this study. For example, the statistical models did not incorporate shifts in consumer perceptions or buying behaviors. While these drivers/factors influence beef demand, it is difficult to quantify them and track how they have changed over time. Furthermore, this study did not include Beef Checkoff program dollars that state beef councils and their respective boards spend on state-level, demand-driving activities.

Methodology

For this economic evaluation, the following econometric models were developed to quantify the relationship between national Beef Checkoff demand-driving activities and the domestic and international demand for U.S. beef:

- Domestic retail demand model
- Domestic retail supply model
- Import demand model

Analyzing the economic evaluation of national Beef Checkoff demand-driving activities in this type of framework enabled the study to filter out the effects of other demand drivers/factors and, hence, directly quantify the net impact of national Beef Checkoff demand-driving activities on domestic and import beef demand.

The following sections provide a general overview of each econometric model used as well as a discussion of the results (an in-depth review of each model is presented in Appendices 1 and 2 of this report).

Econometric Models

To estimate statistical elasticities in domestic retail demand, domestic retail supply, and import demand, each econometric model utilized data observations collected on demand drivers/factors from 2006-2023. When calculating elasticities, more data observations provide greater confidence in the estimated elasticity coefficients, which results in better statistical accuracy regarding conclusions on the relationships among the various demand drivers/factors. Demand driver/factor data observations for each model were as follows:

- Domestic retail demand model was estimated with quarterly data from 2006-2023.
- Domestic retail supply model was estimated with quarterly data from 2006-2023.
- Import demand model was estimated with annual data from each importing country included in this study from 2006-2023.

Domestic Retail Demand Model

To compare the relative importance of each demand driver/factor on domestic beef demand, a domestic retail demand econometric model was developed. Results from this model were converted into "elasticities," which are measurements that represent the percentage change in beef demand given a 1% change in a specific demand driver/factor, holding all other demand drivers/factors constant. For example, the computed own price elasticity of demand for beef measures the percentage change in the quantity of beef demanded given a 1% change in its price, holding all other beef demand drivers/factors constant. Since elasticities were computed for each of the primary categories, comparisons were made to identify the demand drivers/factors that had the greatest influence on domestic beef demand. Furthermore, all monetary demand drivers/factors within the domestic retail model underwent deflation by the Consumer Price Index to remove the effects of inflation.

The retail demand econometric model was estimated using data from the following demand drivers/factors from 2006-2023 to determine their impacts on domestic beef demand:

- Demand in previous period
- Retail price for beef products ($/lb.)
- Retail price for broiler products ($/lb.)
- Retail price for pork products ($/lb.)
- Real disposable income (in real 2017 bil $)
- Time trend
- National primary category:
    - Generic beef advertising
    - Public relations
    - Beef safety research
    - Channels marketing
    - Industry information
    - New product development
    - Product enhancement research
    - Nutritional research

The retail price for beef products was expected to have a negative impact on per capita beef demand as quantity of beef demanded generally falls as the price of beef rises. The retail price for broilers and pork products were included as demand drivers/factors because they are the most significant protein substitutes for beef. Increases in retail price for broiler and pork products were anticipated to positively impact beef demand due to beef's comparative affordability in relation to these protein substitutes. Disposable income was another demand driver/factor that was anticipated to have a positive impact on beef demand. As disposable incomes rise, the demand for beef is expected to increase, reflecting a positive correlation between consumer wealth and beef consumption. The time trend demand driver/factor was included to capture changes in beef availability over time and was expected to have a negative impact on beef demand given recent decreases in beef production. Lastly, the eight national primary categories[4] were expected to have a positive impact on the demand for beef.

Domestic Retail Supply Model

A domestic retail supply econometric model was constructed to estimate the own price elasticity of beef supply, which measured how responsive the quantity supplied of beef was to changes in its own price. Data for the following supply drivers/factors (monetary variables underwent deflation) from 2006-2023 were used to determine their impacts on retail beef supply:

- Retail supply in the previous period
- Retail price for beef products ($/lb.)
- Price of steers ($/lb.)
- Time trend
- Seasonal indicator variables:
    - Quarter 2 indicator variable
    - Quarter 3 indicator variable

Retail supply in the previous period was included as a demand driver/factor to capture dynamics in retail beef supply over time as well as capacity constraints at the retail level. Retail beef price was expected to have a positive impact on retail beef supply as higher retail beef prices increase potential revenue for beef producers, providing a financial incentive to increase production and hence supply. Since the price of steers is acknowledged to significantly influence beef supply, it was anticipated that this driver/factor would exert a negative impact on retail beef supply. As the cost per steer increases, the profit margin for beef producers decreases, which can discourage producers from increasing supply. A time trend factor was included to capture possible omitted variables that may have affected beef supply, and quarterly indicator variables were also incorporated to account for any seasonal trends in retail supply.

[4] Because the foreign market development category contains demand-driving activities that impact U.S. beef import demand, it was not included as a demand driver/factor in the domestic retail demand model.

Import Demand Model

To analyze the economic factors that influence demand for U.S. beef imports in select foreign markets, an import demand econometric model was developed, leveraging annual time series and import country-level data from 2006-2023. These markets included Mexico, Japan, South Korea, Taiwan, Hong Kong, China, and the European Union as they collectively represent the major destinations for U.S. beef imports. Like the domestic econometric models, all monetary variables within the import demand model underwent deflation by the Consumer Price Index to remove the effects of inflation in each importing country.

U.S. beef imports were analyzed as the dependent variable, measured in volume (in kilograms) from 2006-2023 across the seven importing countries. The following import demand drivers/ factors served as independent variables for each of the seven importing countries and were included to determine their respective influences on annual import demand for U.S. beef:

- Unit value (price) of annual beef imports from the U.S. to each importing country in dollars per pound.
- Unit value (price) of annual beef imports from rest-of-the-world (ROW) exporters to each importing country in dollars per pound.
- Average annual gross domestic product (GDP) for each importing country.
- Average annual real exchange rate (ER) of each importing country's currency relative to the U.S. dollar.
- Lagged U.S. beef imports of beef from previous years for each importing country.
- Indicator variable for the COVID-19 pandemic.
- National primary category:
    - Foreign market development

USMEF supplied the U.S. and rest-of-the-world (ROW) beef prices, which were determined by dividing the overall value of beef imports by the total quantity of imports. As a result, both U.S. and ROW beef prices were calculated as unit value measures, covering all categories of beef products, such as muscle cuts, variety meats, and processed beef items, collectively referred to as "total beef" within the dataset.

The price of U.S. beef was expected to negatively impact the volume of U.S. beef imports into each importing country. The law of demand dictates that an increase in the price of U.S. beef correlates with an anticipated decrease in the volume of U.S. beef imports across each importing country. The import demand model also encompassed ROW beef import prices from other foreign markets, as these regions serve as significant sources for beef imports among the seven importing countries and are key competitors to U.S. beef imports. The relationship between the ROW beef price and the import demand for U.S. beef was expected to be positive because ROW beef price is a close substitute for U.S. beef. When the prices of ROW beef rise, consumers may opt to purchase U.S. beef instead, leading to an increase in the demand for U.S. beef imports.

The relationship between gross domestic product (GDP) and the demand for U.S. beef was expected to be positive. As regions experience economic growth and become wealthier, there tends to be an increase in the demand for higher-quality food products, including U.S. beef. Given

the recognized influence of the real exchange rate (ER) on import demand, it was anticipated that the relationship between the ER and demand for U.S. beef imports would be negative. When the U.S. dollar appreciates, making U.S. beef relatively more expensive than beef products from other import competitors, the demand for U.S. beef imports is expected to decline.

Lagged U.S. beef imports, representing imports from previous periods, were incorporated into the import demand model to capture the dynamic effects of international trade rigidities, as U.S. imports from previous years were expected to have a strong correlation with U.S. imports in the current year. Additionally, the indicator variable for COVID-19 was set equal to 0 from 2006-2019 and equal to 1 for 2020-2023.

Econometric Model Results

Domestic Retail Demand Model Results

The domestic retail demand econometric model was estimated with quarterly data from 2006-2023, and the elasticities computed from this model are summarized in Table 1. The coefficient of variation (R^2) indicated that the independent variables used in this study explained 77% of the variations in quarterly per capita demand for U.S. beef. The elasticity relationships in this model were consistent with economic theory and most of the estimated coefficients were statistically significant at the 5% significance level or better. The exception was both the price of broilers and pork were not statistically significant and hence were omitted from the final model. Further, several econometric diagnostic tests were conducted, and results indicated that the domestic retail demand model did not have any statistical issues.

Results showed that the short-run own price elasticity for domestic retail beef price (based on the average for the entire period, 2006-2023) was negative and equal to -0.164. The interpretation of this result is that a 1% increase in the domestic retail beef price, holding all other demand drivers/factors constant, leads to a 0.164% decrease in per capita beef demand. The long-run own price elasticity for domestic retail beef price reported in Table 1 was also negative and slightly larger (-0.218), but findings were still well within the inelastic range. These results indicated that the demand for beef in the U.S. was price inelastic, which is a common finding for most food items in the nation.

Real disposable income, adjusted for inflation, positively influenced beef demand, reflecting beef's classification as a "normal good," where demand rises with increasing consumer income. Interestingly, the responsiveness of per capita beef demand to changes in real disposable income elasticity was greater than its responsiveness to changes in own price elasticity, when considering their magnitudes in absolute terms. This indicated that real disposable income was a significant driver of per capita beef demand. That is, a 1% increase in per capita real disposable income resulted in a 0.282% increase in per capita beef demand in the short-run, holding all other demand drivers/factors constant. The time trend demand driver/factor was also negative and almost significant (p-value = 0.122).

The results showed that each national primary category listed in Table 1, except nutritional research, had a positive and statistically significant impact on increasing per capita beef demand. Holding all other demand drivers/factors constant, a 10% increase in public relations, beef safety research, channels marketing, new product development, product enhancement research, and industry information would increase per capita beef demand by 0.13%, 0.11%, 0.12%, 0.1%, 0.12%, and 0.15% respectively. Generic beef advertising had the highest elasticity at 0.017 indicating a 10% increase in advertising raises per capita beef demand by 0.17%. As previously stated, nutritional research had an elasticity of 0.007 but was not significant (p-value = 0.230).

Because errors are inherent in any statistical model, a 90% confidence interval was computed for each of the primary category's elasticities. This interval can be interpreted as the range of possible values where one can be confident that the true population elasticity could be expected to fall 90% of the time. The 90% confidence interval for the collective impact of generic beef advertising, public relations, beef safety research, channels marketing, new product development, product enhancement research, industry information, and nutritional research were (0.019, 0.151). Because none of the lower bound estimates for the confidence interval were zero or negative, this provided statistical assurance that all national primary categories had a positive and statistically significant impact on per capita beef demand.

Table 1. Domestic retail demand elasticities by demand driver/factor and national primary category.

DEMAND DRIVER/FACTOR[a]	SHORT-RUN ELASTICITY	LONG-RUN ELASTICITY	P-VALUE[b]
Demand in previous period	0.247	NA	0.041
Retail price for beef products ($/lb.)	-0.164	-0.218	0.086
Real disposable income (in real 2017 bil $)	0.282	0.375	0.012
Time trend	-0.052	-0.069	0.122
NATIONAL PRIMARY CATEGORY			
Generic beef advertising	0.017	0.023	0.000
Public relations	0.013	0.017	0.038
Beef safety research	0.011	0.015	0.076
Channels marketing	0.012	0.016	0.038
New product development	0.010	0.013	0.088
Product enhancement research	0.012	0.016	0.047
Industry information	0.015	0.020	0.037
Nutritional research	0.007	0.009	0.230

[a] Domestic retail demand drivers/factors that were not statistically significant are not listed in this table.

[b] A p-value is a measure of statistical significance. Generally, any elasticity that has a p-value less than 0.10 is considered statistically significant.

The domestic retail demand model was simulated over the entire period, 2006-2023, by setting all independent variables equal to historical levels to determine how well the model *predictions* coincided with *actual* per capita beef demand from 2006-2023. The average prediction error (mean absolute percentage error) was 1.57%, which indicates the model had a high degree of accuracy.

Another way to view the elasticity results for each of the national primary categories is to calculate their collective impact on beef demand. The sum of all eight primary categories listed in Table 1 was 0.085. Hence, had there not been any national primary categories (i.e., no domestic demand-driving activities), beef demand would have been 8.5% (0.085*100 = 8.5%) lower (or 2.4 billion pounds per year lower) than actual results over this time-period, 2006-2023.[5] Hence, the efforts of the national Beef Checkoff's domestic demand-driving activities have clearly had a positive and substantial effect on domestic beef demand.

Domestic Retail Supply Model Results

The domestic retail supply econometric model was also estimated with quarterly data from 2006-2023, and the elasticities computed from this model are summarized in Table 2.[6] The coefficient of determination indicated that the independent variables explained over 70% of the variations in quarterly retail supply of U.S. beef. The elasticity relationships were consistent with economic theory and all estimated coefficients were statistically significant at the 10% significance level or better, except for retail pork price, which was significant at the 11% level. Further, several econometric diagnostic tests were conducted, and results indicated that the domestic retail beef supply model did not have any statistical issues.

Results showed that retail supply in the previous period was positive and significantly correlated with retail supply in the current period. Specifically, holding all other retail supply drivers/factors constant, a 1% increase in supply in the previous period increased the retail supply of the current period by 0.569%. The short-run own price elasticity of domestic retail supply was 0.121 and the long-run elasticity was 0.281. That is, holding all other supply drivers/factors constant, a 1% increase in retail beef price resulted in a 0.121% increase in retail beef supply in the short-run and a 0.281% increase in the long-run. The impact of steer price was the same, but negative in value, meaning a 1% increase in steer price resulted in a 0.121% decrease in retail beef supply in the short-run and 0.281% decrease in the long-run. The time trend variable was negative and statistically significant (p-value = 0.045) as it likely captured increases in other retail costs such as energy prices. Two seasonal indicator variables (quarters 2 and 3) were also statistically significant (p-value = 0.000) because, on average, these two quarters had higher retail beef supplies compared to quarters 1 and 4.

[5] This calculation follows from multiplying the sum of all eight national primary category elasticity values (0.085) by 100% to get an estimated total impact of the national Beef Checkoff's domestic demand-driving activities. In other words, since an elasticity is a percentage measure of how demand (or supply) changes given a 1% change in an explanatory variable, multiplying the elasticity value by 100% gives on an estimate of how demand (or supply) would change given a 100% change in the explanatory variable, holding all other drivers/factors constant.

[6] The eight national primary categories listed in Table 1 were not included in the retail supply model since their demand-driving activities only impact retail beef demand and not retail beef supply.

Table 2. Domestic retail supply elasticities by supply driver/factor.

SUPPLY DRIVER/FACTOR	SHORT-RUN ELASTICITY	LONG-RUN ELASTICITY	P-VALUE
Retail supply in the previous period	0.569	NA	0.000
Retail price for beef products ($/lb.)	0.121	0.281	0.021
Steer price	-0.121	-0.281	0.021
Time trend	-0.010	0.023	0.045
Quarter 2 indicator variable	0.040	NA	0.000
Quarter 3 indicator variable	0.032	NA	0.000

Import Demand Model Results

The import demand econometric model for U.S. beef was estimated using data from the seven importing countries with time series data from 2006-2023. Results from this model are presented in Table 3. The import demand model fit the data quite well in terms of the coefficient of variation as over 98% of the variation in the independent variables explained the variation in U.S. beef imports. Like the domestic retail demand and supply models, econometric diagnostic tests were conducted, and results indicated that the U.S. beef import demand model did not have any statistical issues.

The estimated coefficients on the lagged dependent variables were statistically significant for one, two, and three years of lags. Collectively, results showed there was a positive correlation between imports in the previous three years and current imports totaling 0.89. That is, holding all other import demand drivers/factors constant, a 1%increase in imports for the previous three periods increased current imports by 0.89%. Further, the import demand model for U.S. beef found that gross domestic product (GDP), real exchange rates (ER), real price for rest-of-the-world (ROW) beef, and the indicator variable for COVID-19 were not statistically significant; therefore, these import demand drivers/factors were omitted from the results.

The price of U.S. beef is an important demand driver/factor for U.S. beef imports in each of the seven importing countries. Specifically, results showed a negative price elasticity of 0.123, meaning a 1% increase in the price of U.S. beef results in a 0.123% decrease in the quantity demanded for U.S. beef imports, holding all other import demand drivers/factors constant.

The elasticity for the foreign market development category, which included national Beef Checkoff program funds (and other foreign marketing expenditures), had a positive and statistically significant impact on U.S. beef imports to the seven importing countries from 2006-2023. The calculated elasticity for this primary category was 0.115, meaning a 1% increase in beef import demand-driving activities resulted in a 0.115% increase in U.S. beef imports, holding all other import demand drivers/factors constant. The 90% confidence interval computed for foreign market development was (0.072, 0.158), which provided statistical confidence that this primary category had a positive and statistically significant impact on U.S. beef import demand.

Similar to the domestic retail demand model, another way to view the elasticity results for the foreign market development category is in terms of its total impact on U.S. beef import demand. The import demand elasticity for this category was estimated to be 0.115. Hence, had there been any import demand-driving activities (i.e., no foreign market development), U.S. beef import demand would have been 11.5% (0.115*100 = 11.5%) lower than actual results over this time period, 2006-2023. Put in different terms, had there been no foreign market development category, U.S. beef imports would have been, on average, 372 million pounds lower per year than actual results over this time period. Hence, the efforts of the import demand-driving activities within the foreign market development category clearly had a positive and substantial effect on U.S. beef import demand.

Table 3. U.S. beef import demand elasticities by import demand driver/factor and national primary category.

IMPORT DEMAND DRIVER/FACTOR[a]	ELASTICITY	P-VALUE
U.S. beef imports lagged one year	1.133	0.000
U.S. beef imports lagged two years	-0.200	0.023
U.S. beef imports lagged three years	-0.041	0.050
U.S. beef price	-0.123	0.050
NATIONAL PRIMARY CATEGORY		
Foreign market development	0.115	0.000

[a] Import demand drivers/factors that were not statistically significant are not listed in this table.

Average Return-on-Investment (ROI) Market Simulation Model

Once the econometric models were estimated, their inputs (i.e., coefficients) were used in a market simulation model to compute the average ROI for the national Beef Checkoff under two different scenarios. The simulation model utilized data observations from the most recent 5-year period, 2019-2023, to calculate the incremental financial impact, in terms of industry returns and additional benefits, to beef producers and importers for each dollar invested in national Beef Checkoff demand-driving activities.

Domestic Retail Demand and Domestic Retail Supply Market Simulation

The inputs from the domestic retail demand and retail supply econometric models were used in the market simulation model to ascertain the combined impacts of the eight national primary categories on domestic retail market volume, steer price, beef producer revenue generated from beef sales, and ROI for the beef producers and importers. The simulation model was used to run two scenarios:

- Baseline Scenario
- Counterfactual Scenario

The baseline scenario set all retail demand and supply drivers/factors equal to their historical values for the most recent 5-year period, 2019-2023, to measure the impact that the eight national primary categories had on beef demand. The counterfactual scenario set all retail demand and supply drivers/factors equal to their historical values, except for expenditures within the eight national primary categories, which were reduced by 50% to analyze the impacts of reduced funding on domestic beef demand.[7] Since both scenarios were identical, except for expenditure levels within the eight national primary categories, the difference in domestic retail demand between the scenarios provided a measure to gauge the impact of national Beef Checkoff demand-driving activities on domestic beef demand, supply volume, steer price, beef producer revenue generated from beef sales, and the ROI for beef producers and importers.

Import Demand Market Simulation

Like the inputs from the domestic retail demand and retail supply models, the market simulation model utilized inputs from the import demand econometric model to simulate the following two scenarios:

- Baseline Scenario
- Counterfactual Scenario

[7] Instead of a 50% reduction scenario, researchers sometimes use a 100% reduction in promotion/research expenditures to compute an average ROI. However, since the demand equation is specified in logarithmic form, and zero or lower expenditures can give exaggerated results, this study chose to use a 50% instead of 100% reduction to compute the ROI. A similar technique has been used in studies of other commodities such as the Dairy Farmer and Fluid Milk Processors checkoff and American Egg Board evaluations.

For the baseline scenario, the independent variables were set equal to historical levels for the most recent 5-year period, 2019-2023. The counterfactual scenario was identical to the baseline, except expenditures within the foreign market development category (including other foreign marketing expenditures) were reduced by 50%.

Domestic and Import Market Simulation Results

The details of the simulation model are presented in Appendix 2 of this report, but the average rate-of-return was computed and is equal to:

$$ROI = (\Sigma\ \Delta NR_t - \Delta Cost_t)/\ \Sigma\ \Delta Cost_t$$

where: ΔNR_t was the baseline scenario as defined above and $\Delta Cost_t$ was equal to a 50% change in funds expended across the national primary categories.[8] The change in net revenue and change in costs were summed for the most recent 5-year period, 2019-2023. This computation was done collectively for all primary categories to assess the overall ROI for the national Beef Checkoff.

Collectively, the overall average ROI across the national primary categories was $13.41. Hence, the national Beef Checkoff had a very high ROI for its domestic and import demand-driving activities for the most recent 5-year period, 2019-2023. This compares well with the national Beef Checkoff's previous economic evaluation, which reported a combined ROI of 11.91.[9]

The computed ROI was a "point estimate," rather than an exact measure, meaning there was uncertainty about the precision of the estimate. Therefore, a confidence interval was constructed, and it was especially important to estimate the lower bound confidence interval for the ROI. Collectively, the lower bound 90% confidence interval for the ROI was 3.72, which provided additional empirical evidence that the national Beef Checkoff has had a positive and substantial impact on domestic and import beef demand and has provided financial benefits to the beef industry (producers and importers) for the most recent 5-year period, 2013-2023.

The national Beef Checkoff not only had an impact on increasing beef demand domestically and internationally, but also resulted in a higher steer price for beef producers. The results indicated that had there not been any domestic demand-driving activities from 2019-2023, the steer price would have been 7.8% lower per year lower than actual results.

How does the estimated overall ROI for the national Beef Checkoff compare to that of other promotion checkoff programs? Table 4 lists the estimated ROIs for selected food commodities.[10] The ROIs range in value from a low of 1.7 for California avocados to a high of 32.08 for watermelon promotion. The overall ROI for the national Beef Checkoff program of 13.41 is higher than the overall median of all average ROIs in Table 4 (6.50).

[8] The costs associated with each primary category were based on the variable costs of their respective demand-driving activities.

[9] The previous study found a benefit-cost ratio (BCR) of 11.91. Converting this BCR to the ROI measure used in this study corresponds to an ROI of 10.91. Hence, the current study found a higher ROI than the previous 5-year study (2014-2018).

[10] In Table 4, some ROIs are marginal, and some are average. A marginal ROI is interpreted as the incremental return generated from an *extra* dollar invested in a demand-driving activity. An average ROI, which is used in this study, represents the return in net revenue, on average, for each dollar invested in a demand-driving activity.

Table 4. Estimated ROIs for selected commodities.

AUTHOR(S)	COMMODITY	AVERAGE ROI	MARGINAL ROI
Alston et al. (1998)	California Dried Plums	NA	2.70
Crespi and Sexton (2005)	California Almonds	NA	6.20
Kaiser (2022)	Tart Cherries	2.05	NA
Kaiser (2021)	Cranberries	7.70	NA
Schmit et al (1997)	California Eggs	NA	6.90
Carman and Craft (1998)	California Avocados	5.00	1.70
Williams et al. (2004)	Florida Orange Juice	5.00	NA
USDA (2020)	All Dairy	4.78	NA
USDA (2020)	Fluid Milk	3.37	NA
USDA (2020)	Cheese	3.63	NA
USDA (2020)	Butter	15.67	NA
USDA (2020)	Dairy Exports	6.74	NA
Kaiser (2019)	Beef	NA	11.91
Kaiser (2021)	Pork	NA	27.57
Kaiser (2020)	Blueberries	NA	18.74
Murray et al. (2001)	Cotton	4.50	NA
Kaiser (2021)	Walnuts	11.62	NA
Kaiser (2019)	Peanuts	NA	9.74
Kaiser et al. (2012)	Raisins	9.95	NA
Kaiser (2022)	Pears	NA	4.80
Ward (2008)	Honey	6.80	NA
Capps and Williams (2015)	Lamb	NA	7.10
Kaiser (2017)	Watermelons	32.08	NA
Richards and Patterson (2007)	Potatoes	6.50	NA
Kaiser (2019)	Soybeans	NA	12.34
MEDIAN		**6.50**	**7.10**

The Direct & Indirect Effects of National Beef Checkoff Demand-Driving Activities to the Broader Macroeconomy

The demand-driving activities funded with national Beef Checkoff program dollars benefit a range of stakeholders beyond those that invest $1 per head or the import assessment equivalent. For example, local agricultural suppliers benefit from additional feed, seed, fertilizer, etc. purchases, and local workers benefit from higher wages and/or increased opportunities for employment. Federal, state, and local governments also benefit from the extra taxes associated with the incremental financial impact to the beef industry generated by the national Beef Checkoff's demand-driving activities.

To quantify these benefits, the difference in total revenue to the beef industry due to the national Beef Checkoff was first computed by simulating the following two scenarios:

- Baseline Scenario
- Counterfactual Scenario

The baseline scenario measured the average annual total beef revenue from 2019-2023, given average levels of expenditures on national Beef Checkoff demand-driving activities. The counterfactual scenario projected total revenue for the beef industry under simulated domestic retail demand, domestic retail supply, and import demand conditions where no national Beef Checkoff program funds (or other foreign marketing expenditures) were expended on demand-driving activities during this period. The difference between these two scenarios measured the total revenue impacts that the national Beef Checkoff contributed to the beef industry sector, delineating the program's *direct effect*.

The national Beef Checkoff's calculated *direct effect* on total beef market revenue was then fed into an input-output model to measure its *indirect effects* or general economy-wide impacts. More specifically, the input-output model measured the *induced effects* or incremental impacts of the national Beef Checkoff on employment, labor income, value added, tax revenue, and gross domestic product (GDP). These findings offer insight into the broader macroeconomic impacts of the beef industry sector that are attributable to the national Beef Checkoff's demand-driving activities.

A well-known, and well-regarded input-output model called IMPLAN (Impact Analysis for Planning, Mig, Inc.) was used to model the macroeconomic impacts of the national Beef Checkoff on the broader U.S. economy in general. IMPLAN uses a large-scale input-output database representing nearly every industry in the United States.

Direct Effect Results

What were the total direct effects of the national Beef Checkoff to the beef industry sector? As mentioned above, this was the total revenue accruing to the beef industry because of the national Beef Checkoff, and was computed and is equal to:

$$\Delta TR = P(Q - Q')$$

where: P is the steer price, Q is commercial domestic beef disappearance and exports of beef with national Beef Checkoff program dollars (and other foreign marketing program expenditures) from the baseline scenario, and Q' is commercial domestic beef disappearance and exports of beef *without* national Beef Checkoff program dollars (and other foreign marketing program expenditures) from the counterfactual scenario. Domestic commercial disappearance of beef was computed to be 8.5% lower without national Beef Checkoff program dollars than actual results. U.S. beef imports to the seven importing countries were computed to be 11.5% lower without national Beef Checkoff program dollars (and other foreign marketing expenditures) than actual results. Applying these percentages to domestic commercial disappearance and exports, total revenue to the beef industry sector would have been $3.3 billion lower per year had there not been any national Beef Checkoff demand-driving activities for the most recent 5-year period, 2019-2023. The $3.3 billion incremental amount was achieved by higher domestic sales volume (8.5%) and higher export volume (11.5%) due to the national Beef Checkoff's domestic and import demand-driving activities. This was the *direct effect* that the national Beef Checkoff accrued to the beef industry sector.

Indirect Effect Results

As previously mentioned, national Beef Checkoff demand-driving activities benefit a range of stakeholders beyond those that invest $1 per head or the import assessment equivalent. For example, local agricultural suppliers benefit from additional feed, seed, fertilizer, etc. purchases, and local workers benefit from either higher wages and/or increased opportunities for employment. Each of these relationships can be summarized in an "input-output model" that contains data on the technical relationships between each input supply industry, the outputs for the industry in question (incremental total revenue due to national Beef Checkoff demand-driving activities), and broader macroeconomic outputs such as employment, labor income, value-added (a measure of the incremental net returns generated not only for beef producers, but for input suppliers, other segments of the beef supply chain, and wage-earners as well), and gross domestic product (GDP).

The study used the most recent version of IMPLAN to simulate the direct and indirect impacts of the national Beef Checkoff's domestic and import demand-driving activities. The direct domestic impact of the national Beef Checkoff was the average annual incremental increase in industry-wide total revenue due to its activities for the most recent 5-year period, 2109-2023. In the simulation results presented above, this amounted to an incremental increase in total revenue of $3.3 billion per year from national Beef Checkoff demand-driving activities.

The $3.3 billion was inputted into the IMPLAN model as the annual direct effect of the national Beef Checkoff to compute the broader economy-wide indirect effects in the U.S. Using 2023 as a base year, the IMPLAN model was solved to determine the indirect, induced, and total effects of the combined impact of national Beef Checkoff domestic and import demand-driving activities. The indirect effects were the impacts beyond the direct effect to the general economy, and IMPLAN divides them into two effects: "indirect" and "induced." The indirect effects are changes in inter-industry transactions as each input supply industry responds to increased demand from the directly affected industry (i.e., the national Beef Checkoff). For example, the increase in beef sales volume due to national Beef Checkoff demand-driving activities led to increased purchases of inputs and services from beef producers, and the indirect effect of IMPLAN captures this. The induced effects reflect changes in local spending that result from income changes in the directly and indirectly affected industry sectors. The increase in money circulated to the local community has a multiplier effect that enhances the local economy.

The results showed that national Beef Checkoff domestic and import demand-driving activities had substantial impacts on the general economy as illustrated in Table 5. This table displays the detailed impacts of national Beef Checkoff domestic and import demand-driving activities on employment numbers, employment income, value added (a measure of the incremental returns generated not only for beef producers, but for input suppliers, other segments of the beef supply chain, and wage-earners as well), and total economic output (measured as GDP). Further, the direct effect of the national Beef Checkoff added an incremental $3.3 billion to the beef industry in 2023. In addition to the general economy, the national Beef Checkoff had positive spillover effects the following areas:

- Increases in U.S. employment by 46,581 people.
- Increases in U.S. employment income by $2 billion.
- Increases in total value added by $4.1 billion in the U.S.
- Increases in U.S. GDP by almost $9.5 billion.

In addition, the existence of the national Beef Checkoff also increased tax revenue at the federal, state, and local levels. In 2023, this amounted to $34 million in county tax revenue, $205 million in state tax revenue, and $504 million in federal tax revenue for a grand total of $743 million in total tax revenue.

Table 5. Direct, indirect, induced, and total effects of f national Beef Checkoff demand-driving activities in the U.S.

IMPACT TYPE	EMPLOYMENT (NUMBER)	LABOR INCOME (MIL $)	TOTAL VALUE ADDED (MIL $)	GDP (MIL $)
Direct Effect	19,772	459	1,200	3,296
Indirect Effect	17,243	924	1,765	4,148
Induced Effect	9,567	625	1,140	2,020
Total Effect	46,581	2,010	4,105	9,464

Summary and Conclusions

This research study had three central objectives:

1. To measure whether national Beef Checkoff demand-driving activities increased demand of beef products (domestic and abroad) compared to what would have occurred in the absence of these activities.
2. To measure the combined benefits of national Beef Checkoff demand-driving activities in terms of their incremental financial impact to beef producers and importers, and then compare these benefits with the costs of the program to calculate an overall return on investment (ROI) of the national Beef Checkoff program.
3. To measure the indirect benefits of national Beef Checkoff demand-driving activities to the broader macroeconomy?

To address these objectives, econometric models incorporating domestic retail demand, domestic retail supply, and U.S. beef import demand data were developed. This statistical framework enabled the study to determine the impacts of national Beef Checkoff demand-driving activities by factoring out other significant demand drivers/factors such as U.S. beef, chicken, and pork prices, real disposable income, and economic conditions in importing countries.

The main highlights of the study include:

- The national Beef Checkoff had a positive and significant impact on beef demand in the U.S. compared to what it would have been in its absence. Had there not been any domestic demand-driving activities from 2019-2023, total domestic beef demand would have been 2.4 billion pounds (8.5%) lower per year lower than actual results.
- Had there not been any domestic demand-driving activities from 2019-2023, the steer price would have been 7.8% lower per year lower than actual results.
- The national Beef Checkoff (and other foreign marketing expenditures) had a positive and statistically significant impact on U.S. beef imports. Specifically, had there not been any national Beef Checkoff program dollars (and other foreign marketing expenditures) expended on the foreign market development category from 2019-2023, U.S. beef import demand would have been 11.5% lower than actual results from the seven importing countries included in this study.
- Collectively, the ROI for all nine national primary categories was $13.41. In other words, every national Beef Checkoff program dollar invested in each of the primary categories for the most recent 5-year period, 2019-2023, had a positive effect on beef demand, resulting in a total industry-wide financial impact of $13.41 for the beef industry (producers and importers).
- The lower bound 90% confidence interval for the ROI was well above one, adding credence to the findings that the national Beef Checkoff has been profitable for its stakeholders by stimulating the demand for beef (domestic and abroad) via its demand-driving activities.

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Appendix 1. Econometric Models

This Appendix describes the econometric models and results in detail. The three econometric equations that were estimated include: (1) domestic retail demand, (2) domestic retail supply, and (3) import demand. The equations also included two equilibrium conditions requiring domestic retail demand and international demand to equal retail supply, and a farm-to-retail conversion equation. The three econometric equations were used to test whether various activities by the national Beef Checkoff such as advertising, public relations, channels marketing, new product development, foreign market development and promotion activities had a statistically significant impact on beef demand.

Domestic Retail Demand Model

The domestic retail demand econometric model was estimated using data from the following demand drivers/factors from 2006-2023 to determine their impacts on domestic beef demand:

- Retail price for beef products ($/lb.)
- Retail price for broiler products ($/lb.)
- Retail price for pork products ($/lb.)
- Real disposable income (in real 2017 bil $)
- Time trend
- National primary category:
    - Generic beef advertising
    - Public relations
    - Beef safety research
    - Channels marketing
    - Industry information
    - New product development
    - Product enhancement research
    - Nutritional research

Mathematically, the beef domestic demand model was represented by the following equation:

$$\ln(PCCON_t) = \beta 0 + \beta 1 \ln(RBP_t/CPI_t) + \beta 2 \ln(RBRP_t/CPI_t) + \beta 3 \ln(RPP_t/CPI_t) + \beta 4 \ln(INC_t/CPI_t) + \beta 5 \ln(TREND_t) + \beta 6 \ln(BADV_{t-n}/CPI_{t-n}) + \beta 7 \ln(FSAFE_t/CPI_{t-n}) + \beta 8 \ln(CHANNEL_{t-n}/CPI_{t-n}) + \beta 9 \ln(PR_{t-n}/CPI_{t-n}) + \beta 10 \ln(INDUST_{t-n}/CPI_{t-n}) + \beta 11 \ln(NEWPROD_{t-n}/CPI_{t-n}) + \beta 12 \ln(PRODENHANCE_{t-n}/CPI_{t-n}) + \beta 13 \ln(NUTRES_{t-n}/CPI_{t-n})$$

where: $PCCON_t$ is per capita beef domestic demand year/quarter t; RBP_t is retail price for beef products in year/quarter t; CPI_t is the retail consumer price index for all items in year/quarter t; $RBRP_t$ is retail price for broiler products in year/quarter t; RPP_t is the retail price for pork products in year/quarter t; INC_t is disposable income in year/quarter t; $TREND_t$ is a linear trend term in year/quarter t; $BADV_{t-n}$ is national Beef Checkoff generic beef advertising expenditures in year/quarter t, t-1, and so on; PR_t is national Beef Checkoff public relations expenditures in year/quarter t, t-1 and so on; $FSAFE_{t-n}$ is national Beef Checkoff beef safety research expenditures

in year/quarter t, t-1, and so on; $CHANNEL_{t-n}$ is national Beef Checkoff channels marketing expenditures in year/quarter t, t-1, and so on; $INDUST_{t-n}$ is national Beef Checkoff industry information expenditures year/quarter t, t-1, and so on; $NEWPROD_{t-n}$ is national Beef Checkoff new product development expenditures in year/quarter t, t-1, and so on; $PRODENHANCE_{t-n}$ is national Beef Checkoff product enhancement research expenditures in year/quarter t, t-1, and so on and $NUTRES_{t-n}$ is national Beef Checkoff nutritional research expenditures in year/quarter t, t-1, and so on. In this equation, "ln" is the natural logarithmic operator, and the βs are the coefficients to be estimated with statistical regression analysis. The natural logarithm of all national Beef Checkoff demand-driving activity expenditures was used to reflect diminishing returns to these activities. All monetary variables such as RBP, RBRP, RPP, PCINC, PADV, and all national Beef Checkoff expenditures were deflated by the retail Consumer Price Index for all items to account for the effects of inflation over time. Hence, all monetary variables were expressed on a "real," inflation adjusted basis rather than a nominal basis.

The retail price for beef products was expected to have a negative impact on per capita beef demand as quantity of beef demanded generally falls as the price of beef rises. The retail price for broilers and pork products were included as demand drivers/factors because they are the most significant protein substitutes for beef. Increases in retail price for broiler (RBRP) and pork products (RPP) were anticipated to positively impact beef demand (PCCON) due to beef's comparative affordability in relation to these protein substitutes. Disposable income (INC) was another demand driver/factor that was anticipated to have a positive impact on beef demand (PCCON). As disposable incomes rise, the demand for beef is expected to increase, reflecting a positive correlation between consumer wealth and beef consumption. The time trend demand driver/factor was included to capture changes in beef availability over time and was expected to have a negative impact on beef demand given recent decreases in beef production. Lastly, the eight national primary categories were expected to have a positive impact on the demand for beef.

Several specifications were used for the eight primary categories. It is well documented in the literature that promotion campaigns have a "carry-over effect" on demand. That is, past as well as current promotion expenditures influence current demand. To capture this carry-over effect, current and various lagged national Beef Checkoff demand-driving activity expenditures were included in the initial model and the lag-length that provided the best statistical fit was chosen for the final model. All eight national Beef Checkoff primary categories were originally included as separate variables in the per capita beef demand equation. However, due to statistical insignificance of the original specification, the final model consisted of one separate variable for public relations + channels marketing.

Domestic Retail Supply Model

In addition to the domestic retail demand model, a domestic retail supply model was estimated using the following supply drivers/factors from 2006-2023 to determine their impacts on retail beef supply:

- Retail supply in the previous period
- Retail price for beef products ($/lb.)
- Price of steers ($/lb.)
- Time trend
- Seasonal indicator variables:
    - Quarter 2 indicator variable
    - Quarter 3 indicator variable

This model was represented mathematically by the following equation:

$$\ln(RSUP_t) = \eta 0 + \eta 1 \ln(RBP_t/CPI_t) + \eta 2 \ln(STEERP_t/CPI_t) + \eta 3 \ln(RPP_t/CPI_t) + \eta 4 \ln(TREND_t) + \eta 5 \ln(RSUP_{t-1})$$

where: $RSUP_t$ is total retail supply of beef in year/quarter t, RBP_t is retail beef price in year/quarter t, $STEERP_t$ is the 5-market average price of steers in year t/quarter, RPP_t is retail pork price in year/quarter t, $TREND_t$ is a linear time trend variable for year t to measure other variables that may influence the beef retail sector over time such as other costs of production, and $RSUP_{t-1}$ is retail beef supply lagged one quarter. In this equation, the ηs are the coefficients to be estimated with statistical regression analysis. Not shown in this equation are quarterly dummy variables to capture seasonality in retail beef supply.[11] For the price variable, the ratio of the retail beef price to the steer price was used. The steer price was included since this represents the largest variable cost to beef retailers. The retail price of pork represents an opportunity cost for beef retailers. The trend term was included to capture other potential retail beef supply drivers that were not included in the model for beef retailers. This model was also estimated in logarithmic form.

For the domestic retail demand and retail supply econometric models, the following data sources were used for the variables within each model: PCCON, RSUP, RBP, RBRP, RPP, and STEERP came from the Livestock Marketing Information Center; CPI and POP came from the Bureau of Labor Statistics, BADV, FSAFE, CHANEL, INDUST, PR, NEWPROD, PRODENHANCE, and NUTRES came from the Cattlemen's Beef Board.

Import Demand Model

To analyze the economic factors that influence demand for U.S. beef imports in select foreign markets, an import demand econometric model was developed, leveraging annual time series and import country-level data from 2006-2023. These markets included Mexico, Japan, South Korea, Taiwan, Hong Kong, China, and the European Union as they collectively represent the major destinations for U.S. beef imports. Like the domestic econometric models, all monetary

[11] The initial specification of the model included three separate quarterly dummy variables. The final model consisted of only those quarters that had a significant seasonality, which included quarters 2 and 3, which were both higher in value than quarters 1 and 4.

variables within the import demand model underwent deflation by the Consumer Price Index (CPI) to remove the effects of inflation in each importing country.

U.S. beef imports were analyzed as the dependent variable, measured in volume (in kilograms) from 2006-2023 across the seven importing countries. The following import demand drivers/ factors served as independent variables for each of the seven importing countries and were included to determine their respective influences on annual import demand for U.S. beef:

- Unit value (price) of annual beef imports from the U.S. to each importing country in dollars per pound.
- Unit value (price) of annual beef imports from rest-of-the-world (ROW) exporters to each importing country in dollars per pound.
- Average annual gross domestic product (GDP) for each importing country.
- Average annual real exchange rate (ER) of each importing country's currency relative to the U.S. dollar.
- Lagged U.S. beef imports of beef from previous years for each importing country.
- Indicator variable for the COVID-19 pandemic.
- National primary category:
    - Foreign market development

Mathematically, the beef import demand model was represented by the following equation:

$$\ln(M_{it}) = \alpha 0 + \alpha 1 \ln(USP_{it}) + \alpha 2 \ln(ROWP_{it}) + \alpha 3 \ln(GDP_{it}) + \alpha 4 \ln(ER_{it}) + \alpha 5 \ln(FAS_{it}+\text{National Beef Checkoff}_{it}+USMEF_{it}) + \alpha 6 \ln(M_{it-1})$$

where M_{it} is U.S. import quantity in importing region i in year t, USP_{it} is U.S. unit value of imports in region i in year t, $ROWP_{it}$ is the unit value of all non-U.S. imports in region i in year t, GDP_{it} is GDP in importing region i in year t, ER_{it} is the U.S. exchange rate in importing region i in year t, FAS_{it} + national Beef Checkoff_{it}, + $USMEF_{it}$ are beef export promotion expenditures in importing region i in year t, and M_{it-1} is imports in the previous year to region i. In this equation, "ln" is the natural logarithmic operator, and the αs are the coefficients to be estimated with statistical regression analysis.

USMEF supplied the U.S. and rest-of-the-world (ROW) beef prices, which were determined by dividing the overall value of beef imports by the total quantity of imports. As a result, both U.S. and ROW beef prices were calculated as unit value measures, covering all categories of beef products, such as muscle cuts, variety meats, and processed beef items, collectively referred to as "total beef" within the dataset.

The price of U.S. beef was expected to negatively impact the volume of U.S. beef imports into each importing country. The law of demand dictates that an increase in the price of U.S. beef correlates with an anticipated decrease in the volume of U.S. beef imports across each importing country. The import demand model also encompassed ROW beef import prices from other foreign markets, as these regions serve as significant sources for beef imports among the seven importing countries and are key competitors to U.S. beef imports. The relationship between the ROW beef price and the import demand for U.S. beef was expected to be positive because ROW

beef price is a close substitute for U.S. beef. When the prices of ROW beef rise, consumers may opt to purchase U.S. beef instead, leading to an increase in the demand for U.S. beef imports.

The relationship between gross domestic product (GDP) and the demand for U.S. beef was expected to be positive. As regions experience economic growth and become wealthier, there tends to be an increase in the demand for higher-quality food products, including U.S. beef. Given the recognized influence of the real exchange rate (ER) on import demand, it was anticipated that the relationship between the ER and demand for U.S. beef imports would be negative. When the U.S. dollar appreciates, making U.S. beef relatively more expensive than beef products from other import countries, the demand for U.S. beef imports is expected to decline.

Lagged U.S. beef imports (M_{it-1}), representing imports from previous periods, were incorporated into the import demand model to capture dynamic effects of international trade rigidities, as U.S. imports from previous years were expected to be highly correlated with U.S. imports from the current year. Additionally, the indicator variable for COVID-19 was set equal to 0 from 2006-2019 and equal to 1 for 2020-2023.

The following data sources were used for the variables in the import demand model: the quantity, value, and therefore price of U.S. and rest-of-the-world (ROW) beef imports came from USMEF; importing country GDP, ER, and CPI came from the Economic Research Service, USDA; annual USMEF and USDA/FAS export promotion expenditures were provided by USMEF; and national Beef Checkoff expenditures were provided by the Cattlemen's Beef Board.

Econometric Model Results

Domestic Retail Demand Model Results

To address the potential problem of price endogeneity for the demand equation, an endogeneity test was performed on the retail beef price, which consisted of the following steps. First, the retail beef price was regressed on all other explanatory variables in the beef demand equation. The residuals from this regression were then included in the original beef demand equation and a t-test on the estimated coefficient on this residual term was used to test the null hypothesis that the retail beef price is exogenous. In this case, the t-value on the residual term was not statistically significant (t=-0.26) and the null hypothesis therefore could not be rejected. Hence, ordinary least squares was used to estimate the retail beef demand equation.

The domestic retail beef demand econometric model was estimated with quarterly data from 2006-2023, and the elasticities computed from this model are summarized in Table 1. The coefficient of variation (R^2) indicated that the independent variables used in this study explained 77% of the variations in quarterly per capita demand for U.S. beef. The elasticity relationships in this model were consistent with economic theory and most of the estimated coefficients were statistically significant at the 5% significance level or better. The exception was both the price of broilers and pork, which were not statistically significant and hence were omitted from the final model. Further, several econometric diagnostic tests were conducted, and results indicated that the domestic retail demand model did not have any statistical issues.

Results showed that the short-run own price elasticity for domestic retail beef price (based on the average for the entire period, 2006-2023) was negative and equal to -0.164. The interpretation of this result is that a 1% increase in the domestic retail beef price, holding all other demand drivers/factors constant, leads to a 0.164% decrease in per capita beef demand. The long-run own price elasticity for domestic retail beef price reported in Table 1 was also negative and slightly larger (-0.218), but findings were still well within the inelastic range. These results indicated that the demand for beef in the U.S. was price inelastic, which is a common finding for most food items in the nation.

Table 1. Domestic retail demand econometric output.

Dependent Variable: LOG(QUANTB)				
Method: Least Squares				
Included observations: 63 after adjustments				
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)				
VARIABLE	**COEFFICIENT**	**STD. ERROR**	**T-STATISTIC**	**PROB.**
CONSTANT	-1.866746	0.756031	-2.469140	0.0169
LOG(QUANTB(-1))	0.246798	0.117606	2.098506	0.0408
LOG(BEEFP/CPI)	-0.164219	0.093846	-1.749880	0.0862
LOG(RINC)	0.281848	0.108449	2.598894	0.0122
LOG(T)	-0.051682	0.032859	-1.572828	0.1219
LOG(FS(-4)/CPI(-4))	0.011265	0.006230	1.808153	0.0765
LOG(NRES(-9)/CPI(-6))	0.006795	0.005589	1.215936	0.2296
LOG(BAD/CPI)	0.016930	0.002851	5.938238	0.0000
LOG(ENHANCE(-5)/CPI(-5))	0.011811	0.005794	2.038439	0.0467
LOG(PR(-3)+CHAN(-5)/CPI)	0.012655	0.005949	2.127136	0.0383
LOG(INDUSINFO(-9)/CPI(-9))	0.015364	0.007173	2.141953	0.0370
LOG(NPROD/CPI)	0.010228	0.005873	1.741578	0.0876
R-squared	0.772721	Mean dependent var		2.666125
Adjusted R-squared	0.723700	S.D. dependent var		0.043998
S.E. of regression	0.023127	Akaike info criterion		-4.525975
Sum squared resid	0.027278	Schwarz criterion		-4.117759
Log likelihood	154.5682	Hannan-Quinn criter.		-4.365422
F-statistic	15.76307	Durbin-Watson stat		2.389728
Prob(F-statistic)	0.000000	Wald F-statistic		38.45811
Prob(Wald F-statistic)	0.000000			

where: QUANTB is per capita beef demand, QUANTB(-1) is per capita beef demand in previous period, BEEFP is the retail price of beef, CPI is the Consumer Price Index for all items (2023=1), RINC is real per capita disposable income in 2017 dollars, T is a linear time trend, FS is national Beef Checkoff beef safety research expenditures, NRES is national Beef Checkoff nutritional research expenditures, BAD is national Beef Checkoff generic beef advertising expenditures, ENHANCE is national Beef Checkoff product enhancement research expenditures, PR is national Beef Checkoff public relations expenditures, CHAN is national Beef Checkoff channels marketing expenditures, INDUSINFO is national Beef Checkoff industry information expenditures, and NPROD is national Beef Checkoff new product development expenditures.

Real disposable income, adjusted for inflation, positively influenced beef demand, reflecting beef's classification as a "normal good," where demand rises with increasing consumer income. Interestingly, the responsiveness of per capita beef demand to changes in real disposable income elasticity was greater than its responsiveness to changes in own price elasticity, when considering their magnitudes in absolute terms. This indicated that real disposable income was a significant driver of per capita beef demand. That is, a 1% increase in per capita real disposable income resulted in a 0.282% increase in per capita beef demand in the short-run, holding all other demand drivers/factors constant. The time trend demand driver/factor was also negative and almost significant (p-value = 0.122).

The results showed that each national primary category listed in Table 1, except nutritional research, had a positive and statistically significant impact on increasing per capita beef demand. Holding all other demand drivers/factors constant, a 10% increase in public relations, beef safety research, channels marketing, new product development, product enhancement research, and industry information would increase per capita beef demand by 0.13%, 0.11%, 0.12%, 0.1%, 0.12%, and 0.15% respectively. Generic beef advertising had the highest elasticity at 0.017 indicating a 10% increase in advertising raises per capita beef demand by 0.17%. As previously stated, nutritional research had an elasticity of 0.007 but was not significant (p-value = 0.230).

Because errors are inherent in any statistical model, a 90% confidence interval was computed for each of the primary category's elasticities. This interval can be interpreted as the range of possible values where one can be confident that the true population elasticity could be expected to fall 90% of the time. The 90% confidence interval for the collective impact of generic beef advertising, public relations, beef safety research, channels marketing, new product development, product enhancement research, industry information, and nutritional research were (0.019, 0.151). Because none of the lower bound estimates were zero or negative, this provided statistical confidence that all national primary categories had a positive and statistically significant impact on per capita beef demand.

The retail domestic demand model was simulated over the entire period, 2006-2023 by setting all independent variables equal to historical levels to determine how well *predicted* coincided with *actual* per capita beef demand from 2006-2023. The average prediction error (mean absolute percentage error) was 1.57%, which indicated the models had a high degree of accuracy.

Another way to view the elasticity results for each of the national primary categories is to calculate their collective impact on beef demand. The sum of all eight primary categories listed in Table 1 was 0.085. Hence, had there not been any national primary categories (i.e., no domestic demand-driving activities), beef demand would have been 8.5% (0.085*100 = 8.5%) lower (or 2.4 billion pounds per year lower) than actual results over this time-period, 2006-2023.[12] Hence, the efforts of the national Beef Checkoff's domestic demand-driving activities have clearly had a positive and substantial effect on domestic beef demand.

[12] This calculation follows from multiplying the sum of all eight national primary category elasticity values (0.085) by 100% to get an estimated total impact of the national Beef Checkoff's domestic demand-driving activities. In other words, since an elasticity is a percentage measure of how demand (or supply) changes given a 1% change in an explanatory variable, multiplying the elasticity value by 100% gives on an estimate of how demand (or supply) would change given a 100% change in the explanatory variable, holding all other drivers/factors constant.

The national Beef Checkoff not only had an impact on increasing beef demand domestically and internationally, but also resulted in a higher steer price for beef producers. The results indicated that had there not been any domestic demand-driving activities from 2019-2023, the steer price would have been 7.8% lower per year lower than actual results.

Domestic Retail Supply Model Results

The domestic retail supply econometric model was also estimated with quarterly data from 2006-2023, and the elasticities computed from this model are summarized in Table 2.[13] The coefficient of determination indicated that the independent variables explained over 70% of the variations in quarterly retail supply of U.S. beef. The elasticity relationships were consistent with economic theory and all estimated coefficients were statistically significant at the 10% significance level or better, except for retail pork price which was significant at the 11% level. Further, several econometric diagnostic tests were conducted, and results indicated that the domestic retail beef supply model did not have any statistical issues.

Table 2. Domestic retail supply econometric output.

Dependent Variable: LOG(QUANTB*POP)				
Method: Least Squares				
Included observations: 71 after adjustments				
Huber-White-Hinkley (HC1) heteroskedasticity consistent standard errors and covariance				
VARIABLE	**COEFFICIENT**	**STD. ERROR**	**T-STATISTIC**	**PROB.**
CONSTANT	6.994753	1.993858	3.508150	0.0008
LOG(QUANTB(-1)*POP(-1)	0.569338	0.121281	4.694390	0.0000
LOG(BEEFP/STEERP)	0.121120	0.051289	2.361502	0.0212
LOG(T)	-0.009764	0.004777	-2.043983	0.0450
DUM2	0.039884	0.010106	3.946708	0.0002
DUM3	0.031917	0.008008	3.985724	0.0002
R-squared	0.708492	Mean dependent var		15.35229
Adjusted R-squared	0.686069	S.D. dependent var		0.049904
S.E. of regression	0.027961	Akaike info criterion		-4.235283
Sum squared resid	0.050819	Schwarz criterion		-4.044071
Log likelihood	156.3525	Hannan-Quinn criter.		-4.159244
F-statistic	31.59574	Durbin-Watson stat		2.574764
Prob(F-statistic)	0.000000	Wald F-statistic		49.76380
Prob(Wald F-statistic)	0.000000			

where: QUANTB is per capita beef demand, POP is total civil population of the United States, QUANTB(-1) is per capita beef demand in previous period, POP(-1) is total civil population of the United States in the previous period, BEEFP is the retail price of beef, STEERP is the steer price per cwt., T is a linear trend term, and DUM2 and DUM3 are quarterly dummy variables for quarters 2 and 3.

[13] The eight national primary categories listed in Table 1 were not included in the retail supply model since their demand-driving activities only impact retail beef demand and not retail beef supply.

Results showed that retail supply in the previous period was positive and significantly correlated with retail supply in the current period. Specifically, holding all other retail supply drivers/factors constant, a 1% increase in supply in the previous period increased the retail supply of the current period by 0.569%. The short-run own price elasticity of domestic retail supply was 0.121 and the long-run elasticity was 0.281. That is, holding all other supply drivers/factors constant, a 1% increase in retail beef price results in a 0.121% increase in retail beef supply in the short-run and a 0.281% increase in the long-run. The impact of steer price was the same, but negative in value, meaning a 1% increase in steer price results in a 0.121% decrease in retail beef supply in the short-run and 0.281% decrease in the long-run. The time trend variable was negative and statistically significant (p-value = 0.045) as it likely captures increases in other retail costs such as energy prices. Two seasonal indicator variables (quarters 2 and 3) were also statistically significant because, on average, these two quarters had higher retail beef supplies compared to quarters 1 and 4.

Import Demand Model Results

The import demand econometric model for U.S. beef was estimated using data from the seven importing countries with time series data from 2006-2023. Results from this model are presented in Table 3. The import demand model fit the data quite well in terms of the coefficient of variation as over 98% of the variation in the independent variables explained the variation in U.S. beef imports. Like the domestic demand and supply models, econometric diagnostic tests were conducted, and results indicated that the U.S. beef import demand model did not have any statistical issues.

The estimated coefficients on the lagged dependent variables were statistically significant for one, two, and three years of lags. Collectively, results showed there was a positive correlation between imports in the previous three years and current imports totaling 0.89. That is, holding all other import demand drivers/factors constant, a 1% increase in imports for the previous three periods increased current imports by 0.89%. Further, the import demand model for U.S. beef found that gross domestic product (GDP), real exchange rates (ER), real price for rest-of-the-world (ROW) beef, and the indicator variable for COVID-19 were not statistically significant; therefore, these import demand drivers/factors were omitted from the results.

The U.S. beef price is an important demand driver/factor for U.S. beef imports in each of the seven importing countries. Specifically, results showed a negative price elasticity of 0.123, meaning a 1% increase in the price of U.S. beef results in a 0.123% decrease in the quantity demanded for U.S. beef imports, holding all other import demand drivers/factors constant.

The elasticity for the foreign market development category, which included national Beef Checkoff program funds and annual USMEF and USDA/FAS export promotion expenditures, had a positive and statistically significant impact on U.S. beef imports to the seven importing countries from 2006-2023. The calculated elasticity for this primary category was 0.115, meaning a 1% increase in beef import demand-driving activities results in a 0.115% increase in U.S. beef imports, holding all other import demand drivers/factors constant. The 90% confidence interval computed for foreign market development was (0.072, 0.158), which provided statistical confidence that this primary category had a positive and statistically significant impact on U.S. beef import demand.

Table 3. Import demand econometric output.

Dependent Variable: LOG(USQ)				
Method: Panel EGLS (Cross-section weights)				
Total panel (balanced) observations: 105				
Linear estimation after one-step weighting matrix				
Cross-section weights (PCSE) standard errors & covariance (no d.f. correction)				
VARIABLE	**COEFFICIENT**	**STD. ERROR**	**T-STATISTIC**	**PROB.**
LOG(USQ(-1))	1.132757	0.087548	12.93877	0.0000
LOG(USQ(-2))	-0.199744	0.087901	-2.272379	0.0252
LOG(USQ(-3))	-0.041296	0.021469	-1.923554	0.0573
LOG(USP/CPI)	-0.122983	0.062370	-1.971825	0.0514
LOG((National Beef CheckoffPROM(-1)+FAS(-1)+USFPROM(-1)/CPI))	0.114633	0.025860	4.432808	0.0000
	WEIGHTED STATISTICS			
R-squared	0.976717	Mean dependent var		67.86594
Adjusted R-squared	0.975786	S.D. dependent var		39.29330
S.E. of regression	0.663416	Sum squared resid		44.01213
Durbin-Watson stat	2.182419			
	UNWEIGHTED STATISTICS			
R-squared	0.956762	Mean dependent var		17.15877
Sum squared resid	55.51597	Durbin-Watson stat		2.082018

where: USQ is volume of beef imports, USQ(-1), USQ(-2) USQ(-3) is volume of beef imports lagged 1, 2, and 3 years, USP is the U.S. beef price, CPI is the Consumer Price Index for all items in the importing country, national Beef CheckoffPROM(-1) is national Beef Checkoff(-1) expenditures on U.S. beef export promotion lagged one period, FAS(-1) is FAS expenditures on U.S. beef export promotion lagged one period, and USFPROM(-1) is USMEF expenditures on U.S. beef export promotion lagged one period.

Similar to the domestic retail demand model, another way to view the elasticity results for the foreign market development category is in terms of its total impact on U.S. beef import demand. The import demand elasticity for this category was estimated to be 0.115. Hence, had there been any import demand-driving activities (i.e., no foreign market development), U.S. beef import demand would have been 11.5% (0.115*100 = 11.5%) lower than actual results over this time period, 2006-2023. Put in different terms, had there been no foreign market development category, U.S. beef imports would have been, on average, 372 million pounds lower per year than actual results over this time period. Hence, the efforts of the import demand-driving activities within the foreign market development category clearly had a positive and substantial effect on U.S. beef import demand.

Appendix 2. Market Simulation Model for Average Return on Investment (ROI)

To evaluate the full effect of the national Beef Checkoff program's demand-enhancing activities on quantity and price, one needed to incorporate the retail supply response of beef into the model. This study used the long-run price elasticity of beef supply that was estimated in the domestic retail supply model for the supply response. The estimated long-run supply elasticity was 0.281. The study also needed an estimate of the farm beef supply elasticity, but since a farm beef supply equation was not estimated in this study, the own price elasticity of beef supply was taken from a previous study by Marsh, who estimated an intermediate (i.e., 18-month) own-supply elasticity for beef to be 0.61. That is, a 1% increase in the beef price would lead to a 0.61% increase in quantity supplied of beef over an 18-month period.

The simulation procedure for computing the average rate-of-return began on the demand side, where predicted quantities of beef demand (Q_t^D) were estimated from the domestic retail demand equation. Then, using a procedure similar to that in Alston et al. (1996), supply was defined in constant elasticity form and equated with the predicted demand quantities. Changes in demand due to national Beef Checkoff demand-driving activities then affect the level of production and the resulting farm price. Specifically, the supply function was defined as:

(1) $QtS = At\ Pt$

where $A_t = Q_t^D / P_t$ and P_t is the retail beef price. The defined value, A_t, varied by quarter and ensured that, given the actual values of prices and other variables, the supply equation passed through the quantity defined by Q_t^D. This made possible the combining of the supply response and estimated demand model to simulate past retail prices and quantities.

Given the simulation procedures described above, the change in net economic benefits due to national Beef Checkoff demand-driving activities were computed for each quarter from 2019 to 2023 as the difference in producer surplus (i.e., net revenue) between the following two scenarios: (1) historic or baseline scenario with national Beef Checkoff demand-driving activities expenditures set to actual levels, and (2) reduced national Beef Checkoff or counterfactual scenario where national Beef Checkoff demand-driving activities expenditures were set 50% lower than the actual expenditures. One could have simulated a zero national Beef Checkoff program spending scenario, but since the demand model was specified in logarithmic form, reducing expenditures to zero or even low levels could produce exaggerated results given this functional form. The difference between the baseline and 50% reduced national Beef Checkoff program expenditures scenarios provided a measure of the average impact of the national Beef Checkoff's demand-driving activities spending, i.e., how the average dollar spent impacts the market.

To do this, we first had to translate the retail beef price into the steer price to compute net returns at the beef producer level. This was done by using the following estimated price transmission equation:

$$STEERP = -18.70 + 9.93*RPRICE - 0.368*T + 0.81*STEERP(-1)$$

where: STEERP is the steer price, RPRICE is the retail price of beef per pound, T is a linear trend term, and STEERP(-1) is the steer price in the previous period.

The change in net revenue (what economists call producer surplus) was computed as follows:

$$\Delta NR_t = (STEERP_t\, Q_t - STEERP'_t\, Q'_t)/(1 + \varepsilon),$$

where $STEERP_t\, Q_t$ represents total revenue to beef producers and importers for the baseline scenario with 100% national Beef Checkoff demand-driving activity expenditures, $STEERP_t'\, Q_t'$ represents total revenue to beef producers for the scenario with 50% reduced demand-driving activity expenditures, and ε represents the own elasticity of supply for beef producers set to 0.61 (Marsh).

An average rate-of-return was computed and was equal to:

$$ROI = (S\, \Delta NR_t - \Delta Cost_t)/ S\, \Delta Cost_t$$

where: ΔNR_t is as defined above and $\Delta Cost_t$ is equal to a 50% change in cost of the national Beef Checkoff program expenditures on demand-driving activities The change in net revenue and change in costs were summed over the period 2019 through 2023. This computation was done for overall national Beef Checkoff demand-driving activities.

Identical procedures were done for generating the average ROI for foreign market development in the import demand model. Two scenarios were run: (1) baseline scenario with historical spending by national Beef Checkoff program, USMEF, and USDA/FAS, and (2) reduced-export promotion or counterfactual scenario, where export promotion expenditures by the national Beef Checkoff program, USMEF, and USDA/FAS was reduced by 50%. Unfortunately, there was no available estimate of the U.S. beef export supply price elasticity, however, economic theory suggests that export supply for agricultural products tends to be quite elastic. Jeong (2019) estimated the own price elasticity for fed cattle to be 1.813, which was used here.

Data Used in Domestic Demand and Supply Models

YEAR. QUARTER	BEEF ADVERTISING $	BEEF PRICE $/LB.	BROILER PRICE $/LB.	CHANNELS MARKETING $	CONSUMER INFORMATION $	CPI ALL ITEMS 1980-82=100
2006Q1	4,690,157	4.05	1.05	1,524,442	244,029	198.9
2006Q2	5,560,413	3.96	1.05	2,199,436	1,509,252	202.3
2006Q3	3,887,301	3.93	1.05	3,000,481	1,564,795	203.4
2006Q4	995,499	3.94	1.05	1,202,652	1,453,390	201.7
2007Q1	850,244	4.06	1.05	1,469,437	2,202,474	203.8
2007Q2	5,120,969	4.27	1.12	2,681,050	1,555,197	207.7
2007Q3	8,336,167	4.18	1.14	2,856,363	1,557,016	208.2
2007Q4	1,078,111	4.13	1.15	1,726,152	2,120,112	209.7
2008Q1	3,903,665	4.16	1.16	1,508,706	1,462,835	212.1
2008Q2	4,583,703	4.24	1.18	1,799,840	1,265,989	216.8
2008Q3	3,577,431	4.46	1.21	2,299,125	1,329,760	219.3
2008Q4	603,843	4.45	1.27	1,152,957	1,804,383	213.1
2009Q1	2,839,827	4.32	1.29	1,685,372	892,321	212.0
2009Q2	2,698,516	4.29	1.29	1,519,849	1,091,010	214.3
2009Q3	3,254,003	4.18	1.27	1,769,128	1,077,678	215.7
2009Q4	210,345	4.24	1.26	1,096,459	1,028,556	216.2
2010Q1	1,667,029	4.22	1.25	1,480,103	1,306,469	217.0
2010Q2	3,629,849	4.45	1.24	1,787,295	1,264,362	218.1
2010Q3	4,432,094	4.40	1.27	2,295,939	656,997	218.3
2010Q4	783,412	4.47	1.29	852,396	1,161,652	218.9
2011Q1	1,110,345	4.61	1.26	1,492,815	1,010,803	221.7
2011Q2	3,618,788	4.80	1.29	1,406,488	1,032,579	225.5
2011Q3	3,796,455	4.85	1.30	2,393,265	1,128,518	226.5
2011Q4	789,224	4.97	1.32	1,070,420	1,052,163	226.1
2012Q1	877,727	5.03	1.35	1,534,933	1,005,376	227.9
2012Q2	3,339,375	4.92	1.38	1,360,136	1,492,478	229.8
2012Q3	3,248,890	4.94	1.45	2,378,260	963,461	230.3
2012Q4	749,747	5.06	1.51	1,295,275	680,172	230.4
2013Q1	542,364	5.22	1.47	1,074,417	536,679	231.7
2013Q2	4,855,708	5.24	1.48	1,404,537	1,008,508	233.0
2013Q3	3,158,213	5.33	1.50	1,979,775	858,116	233.9
2013Q4	85,459	5.37	1.53	189,775	973,949	233.2
2014Q1	498,932	5.55	1.53	735,559	1,663,305	235.0
2014Q2	3,111,170	5.90	1.53	1,352,608	3,145,184	237.8
2014Q3	3,000,232	6.15	1.54	960,112	2,732,069	238.0
2014Q4	775,040	6.28	1.54	778,161	2,211,320	236.1
2015Q1	1,643,453	6.30	1.55	1,695,870	3,211,857	234.8
2015Q2	2,214,117	6.41	1.51	1,048,443	2,316,181	237.7
2015Q3	2,844,680	6.31	1.44	1,273,517	2,821,599	238.3
2015Q4	598,699	6.06	1.45	519,904	1,347,272	237.2
2016Q1	1,522,983	6.06	1.46	1,218,890	2,097,441	237.4
2016Q2	1,149,921	6.13	1.46	844,255	1,300,771	240.2
2016Q3	4,413,100	5.96	1.45	1,286,894	2,548,387	241.0
2016Q4	379,537	5.71	1.48	1,129,454	1,777,607	241.5
2017Q1	2,210,827	5.80	1.45	1,810,164	2,318,315	243.4

2017Q2	2,052,186	6.09	1.48	984,173	1,546,915	244.7
2017Q3	2,494,513	5.95	1.49	1,230,503	2,202,982	245.7
2017Q4	1,530,284	5.79	1.47	1,221,105	1,855,051	246.6
2018Q1	1,086,592	5.82	1.50	1,297,232	1,765,875	249.5
2018Q2	3,880,777	6.00	1.52	867,500	1,320,516	251.4
2018Q3	2,925,006	6.01	1.51	1,216,654	2,409,752	252.2
2018Q4	1,651,251	5.86	1.47	917,455	3,772,848	252.1
2019Q1	2,878,513	5.94	1.48	809,045	1,440,002	252.9
2019Q2	2,771,555	6.14	1.51	881,444	1,374,349	255.9
2019Q3	3,175,713	6.08	1.52	764,014	1,599,670	256.6
2019Q4	2,017,351	6.02	1.47	566,348	1,262,457	257.2
2020Q1	2,845,925	6.05	1.39	1,470,370	2,562,585	258.3
2020Q2	2,147,419	7.20	1.63	1,099,478	2,394,638	256.9
2020Q3	3,056,289	6.57	1.62	1,101,043	2,233,498	259.8
2020Q4	1,081,861	6.33	1.61	751,638	1,716,340	260.4
2021Q1	2,413,569	6.43	1.57	1,513,145	2,801,468	263.2
2021Q2	1,800,851	7.06	1.49	683,275	2,254,154	269.3
2021Q3	3,093,428	7.68	1.47	965,101	2,064,629	273.6
2021Q4	1,499,657	7.81	1.57	741,943	1,490,752	277.8
2022Q1	3,742,850	7.64	1.66	335,712	1,617,416	284.1
2022Q2	3,064,585	7.69	1.81	142,775	2,201,404	292.6
2022Q3	4,923,313	7.60	1.88	187,159	2,720,230	296.4
2022Q4	1,933,861	7.41	1.85	54,592	1,640,455	297.5
2023Q1	2,466,319	7.60	1.87	182,322	2,355,458	300.6
2023Q2	1,054,853	8.02	1.92	70,868	1,422,954	304.2
2023Q3	3,057,930	8.24	1.92	94,424	2,390,931	306.8
2023Q4	1,903,455	8.17	1.93	78,173	1,226,355	307.7

Data Used in Domestic Demand and Supply Models

YEAR. QUARTER	PRODUCT ENHANCEMENT $	BEEF SAFETY RESEARCH $	INDUSTRY INFORMATION $	NEW PRODUCT DEVELOPMENT $	NUTRITIONAL RESEARCH $
2006Q1	339,340	407,806	341,684	194,033	194,033
2006Q2	543,968	925,444	276,898	169,392	169,392
2006Q3	706,799	502,776	460,027	408,000	408,000
2006Q4	295,041	494,055	303,827	82,063	82,063
2007Q1	298,686	412,350	314,734	162,000	162,000
2007Q2	524,003	564,084	454,311	740,376	740,376
2007Q3	434,747	577,696	470,879	366,565	366,565
2007Q4	306,166	475,921	454,481	837,291	837,291
2008Q1	421,786	391,436	633,698	493,214	493,214
2008Q2	373,175	799,841	619,452	626,575	626,575
2008Q3	375,575	418,507	908,668	663,434	663,434
2008Q4	252,832	244,502	481,749	150,087	150,087
2009Q1	262,312	173,358	630,252	374,401	374,401
2009Q2	530,809	570,686	615,177	643,539	643,539
2009Q3	245,953	301,903	832,645	667,703	667,703
2009Q4	163,833	309,410	449,900	439,549	439,549
2010Q1	277,306	209,477	585,137	507,585	507,585
2010Q2	454,933	260,600	779,524	683,686	683,686
2010Q3	252,780	621,906	1,171,422	538,013	538,013
2010Q4	152,069	258,272	653,942	359,033	359,033
2011Q1	210,438	349,242	839,882	311,769	311,769
2011Q2	232,980	375,551	745,852	371,286	371,286
2011Q3	329,455	242,848	1,296,286	583,779	583,779
2011Q4	61,323	187,097	561,229	331,202	331,202
2012Q1	239,803	446,961	741,097	456,048	456,048
2012Q2	107,174	197,086	835,783	360,444	360,444
2012Q3	463,258	297,996	1,550,045	850,997	850,997
2012Q4	272,285	286,993	489,280	289,465	289,465
2013Q1	75,132	397,685	1,031,533	246,939	246,939
2013Q2	358,671	110,387	904,699	302,025	302,025
2013Q3	237,554	567,515	1,185,601	465,896	465,896
2013Q4	112,251	34,127	95,067	402,497	402,497
2014Q1	273,966	279,775	702,734	616,373	616,373
2014Q2	272,389	268,575	1,335,303	675,623	675,623
2014Q3	689,782	397,842	1,124,976	532,333	532,333
2014Q4	103,608	264,781	812,095	320,630	320,630
2015Q1	362,573	453,449	1,355,242	579,167	579,167
2015Q2	332,576	546,606	1,139,830	547,536	547,536
2015Q3	566,944	342,390	1,415,109	1,631,563	1,631,563
2015Q4	48,901	111,066	733,970	321,546	321,546
2016Q1	300,565	654,638	1,468,947	733,587	321,546
2016Q2	146,570	317,808	782,895	441,953	733,587
2016Q3	571,573	678,486	1,026,124	747,493	441,953
2016Q4	40,095	87,633	440,538	628,179	747,493
2017Q1	375,014	345,084	1,517,457	723,730	628,179

2017Q2	150,004	338,244	1,588,031	898,738	723,730
2017Q3	585,339	487,449	1,800,585	659,260	898,738
2017Q4	150,588	236,316	1,466,906	500,275	659,260
2018Q1	389,035	302,020	1,061,671	714,925	500,275
2018Q2	218,830	271,830	984,686	458,143	714,925
2018Q3	630,831	142,622	768,483	547,083	458,143
2018Q4	113,431	138,965	855,792	823,910	547,083
2019Q1	610,263	298,433	921,999	358,947	823,910
2019Q2	734,675	188,493	1,460,142	662,915	358,947
2019Q3	922,158	469,459	950,461	452,085	662,915
2019Q4	183,486	59,753	2,045,931	738,872	452,085
2020Q1	639,172	196,231	868,504	882,223	738,872
2020Q2	250,766	445,682	1,487,430	588,159	882,223
2020Q3	454,348	386,968	1,274,862	756,963	588,159
2020Q4	320,788	267,149	1,124,744	604,364	756,963
2021Q1	313,803	327,816	1,738,363	678,765	604,364
2021Q2	159,304	176,945	1,301,044	714,815	678,765
2021Q3	451,991	625,903	1,569,031	690,435	714,815
2021Q4	183,150	213,428	906,832	463,717	690,435
2022Q1	412,374	301,605	712,094	894,131	463,717
2022Q2	374,806	492,970	1,022,257	843,072	894,131
2022Q3	236,730	374,771	1,254,615	798,022	843,072
2022Q4	239,851	202,706	1,293,438	332,228	798,022
2023Q1	233,410	586,170	824,205	1,014,379	332,228
2023Q2	241,149	530,854	1,354,810	743,898	1,014,379
2023Q3	409,135	414,049	1,130,875	677,763	743,898
2023Q4	129,736	264,668	1,036,752	460,194	677,763

Data Used in Domestic Demand and Supply Models

YEAR. QUARTER	US POPULATION 1,000	PORKP PRICE $/LB.	PUBLIC RELATIONS $	DOMESTIC PROMOTION $	PER CAPITA BEEF DEMAND LBS.
2006Q1	297,434	2.77	1,324,982	5,567,236	15.76
2006Q2	298,097	2.79	1,439,293	9,075,761	16.89
2006Q3	298,865	2.86	3,121,676	5,980,909	16.99
2006Q4	299,666	2.81	958,804	4,265,007	16.17
2007Q1	300,389	2.81	1,068,479	4,001,326	15.69
2007Q2	301,064	2.87	2,177,876	6,861,164	16.66
2007Q3	301,846	2.92	2,418,180	11,185,592	16.58
2007Q4	302,621	2.88	2,337,451	4,444,273	16.14
2008Q1	303,290	2.84	1,457,164	5,734,129	15.33
2008Q2	303,905	2.90	1,477,211	6,283,756	16.30
2008Q3	304,632	3.00	2,308,344	7,189,443	15.80
2008Q4	305,357	3.01	1,128,167	2,966,073	15.10
2009Q1	305,982	2.97	1,136,140	4,767,884	14.92
2009Q2	306,562	2.94	1,562,794	5,408,593	15.63
2009Q3	307,257	2.93	1,846,304	4,220,696	15.50
2009Q4	307,981	2.84	1,150,003	2,343,617	14.65
2010Q1	308,591	2.90	1,239,121	4,001,344	14.37
2010Q2	308,941	3.02	1,273,316	3,261,115	15.05
2010Q3	309,540	3.24	1,465,027	7,766,598	15.31
2010Q4	310,171	3.29	751,513	3,932,602	14.73
2011Q1	310,688	3.29	1,244,925	2,161,693	14.04
2011Q2	311,181	3.45	782,456	4,955,348	14.49
2011Q3	311,773	3.51	1,700,688	6,732,666	14.61
2011Q4	312,398	3.48	780,447	3,139,741	14.01
2012Q1	312,944	3.49	955,219	2,916,374	14.08
2012Q2	313,455	3.42	1,101,546	6,309,184	14.54
2012Q3	314,054	3.49	1,537,818	6,132,550	14.36
2012Q4	314,689	3.46	732,370	2,108,035	14.22
2013Q1	315,166	3.49	1,085,621	3,019,969	13.76
2013Q2	315,626	3.56	1,053,781	4,389,730	14.46
2013Q3	316,210	3.75	1,594,081	6,011,033	14.16
2013Q4	316,863	3.78	183,761	2,548,273	13.81
2014Q1	317,405	3.77	748,802	689,511	12.96
2014Q2	317,917	4.05	1,469,859	3,203,787	13.82
2014Q3	318,538	4.18	1,416,051	2,998,723	13.75
2014Q4	319,213	4.07	1,285,594	817,722	13.57
2015Q1	319,740	3.93	1,869,156	1,968,382	13.16
2015Q2	320,246	3.72	1,237,474	2,342,011	13.62
2015Q3	320,857	3.84	1,415,741	2,962,785	13.98
2015Q4	321,508	3.91	570,697	203,246	13.32
2016Q1	322,032	3.76	570,697	1,594,344	13.45
2016Q2	322,550	3.78	1,070,954	1,226,210	13.87
2016Q3	323,144	3.79	1,055,627	4,524,759	14.20
2016Q4	323,737	3.65	1,982,142	536,032	14.09
2017Q1	324,209	3.66	1,123,901	2,299,725	13.69

2017Q2	324,640	3.74	1,260,428	2,091,128	14.08
2017Q3	325,161	3.92	1,237,309	2,515,224	14.63
2017Q4	325,658	3.81	1,504,980	1,605,468	14.23
2018Q1	326,033	3.75	998,353	1,084,912	13.84
2018Q2	326,395	3.73	1,265,564	3,873,214	14.41
2018Q3	326,850	3.78	897,248	2,934,767	14.53
2018Q4	327,304	3.72	1,853,135	3,357,528	14.35
2019Q1	327,636	3.75	1,291,529	4,030,179	13.95
2019Q2	327,968	3.86	512,627	2,809,865	14.79
2019Q3	328,409	3.90	1,091,777	3,317,581	14.54
2019Q4	328,885	3.86	1,355,277	2,047,343	14.83
2020Q1	331,440	3.85	870,089	2,839,963	14.73
2020Q2	331,444	4.06	1,536,698	2,200,136	13.58
2020Q3	331,586	4.11	1,720,142	3,192,092	15.54
2020Q4	331,794	4.10	1,512,468	1,076,224	14.52
2021Q1	331,742	4.15	1,271,461	2,547,100	14.57
2021Q2	331,862	4.42	1,767,022	1,804,925	14.89
2021Q3	332,170	4.66	1,776,319	3,120,938	14.61
2021Q4	332,491	4.79	1,421,114	1,675,179	14.80
2022Q1	332,694	4.78	1,141,183	3,354,501	15.01
2022Q2	333,001	4.90	1,293,066	2,515,222	14.68
2022Q3	333,462	4.96	1,853,895	4,364,728	14.68
2022Q4	333,963	4.94	2,160,803	1,608,833	14.51
2023Q1	334,336	4.77	1,373,132	2,808,903	14.82
2023Q2	334,751	4.71	2,061,791	1,276,206	14.35
2023Q3	335,166	4.84	1,243,056	3,600,128	14.22
2023Q4	335,657	5.04	2,349,974	1,479,539	14.00

Data Used in Domestic Demand and Supply Models

YEAR. QUARTER	RESEARCH $	REAL INCOME 2017 BIL $	STEER PRICE $/CWT.	TREND TERM #
2006Q1	371,424	11,701	90.06	1
2006Q2	1,745,151	11,744	81.12	2
2006Q3	3,041,225	11,761	85.34	3
2006Q4	1,031,914	11,905	87.25	4
2007Q1	2,450,669	11,996	91.24	5
2007Q2	1,110,379	12,055	94.47	6
2007Q3	2,135,364	12,076	92.06	7
2007Q4	1,824,637	12,090	92.67	8
2008Q1	2,548,313	12,142	90.88	9
2008Q2	2,107,087	12,392	92.83	10
2008Q3	1,455,940	12,153	98.52	11
2008Q4	1,223,935	12,291	88.88	12
2009Q1	1,307,270	12,282	82.18	13
2009Q2	1,566,953	12,364	84.48	14
2009Q3	1,907,256	12,215	83.05	15
2009Q4	1,182,539	12,233	83.29	16
2010Q1	1,517,381	12,306	89.44	17
2010Q2	1,492,337	12,511	96.33	18
2010Q3	1,379,422	12,578	95.47	19
2010Q4	1,210,758	12,626	100.27	20
2011Q1	1,679,202	12,753	110.07	21
2011Q2	1,256,826	12,728	112.79	22
2011Q3	1,585,706	12,796	114.05	23
2011Q4	589,147	12,824	121.99	24
2012Q1	1,814,940	13,021	125.30	25
2012Q2	2,011,757	13,109	120.91	26
2012Q3	1,303,871	13,005	119.69	27
2012Q4	1,201,124	13,367	125.54	28
2013Q1	1,836,532	12,837	125.51	29
2013Q2	1,335,519	12,934	124.95	30
2013Q3	1,662,926	12,980	122.30	31
2013Q4	1,288,384	12,998	130.77	32
2014Q1	3,228,922	13,149	146.34	33
2014Q2	2,104,939	13,314	147.82	34
2014Q3	2,527,827	13,440	158.49	35
2014Q4	1,238,911	13,631	165.59	36
2015Q1	2,775,368	13,819	162.43	37
2015Q2	2,182,521	13,861	158.11	38
2015Q3	3,618,558	13,938	144.22	39
2015Q4	848,309	14,017	127.72	40
2016Q1	2,760,434	14,131	107.69	41
2016Q2	1,730,189	14,102	134.81	42
2016Q3	3,039,846	14,182	127.68	43
2016Q4	1,113,679	14,274	113.22	44
2017Q1	2,611,422	14,422	107.69	45

2017Q2	2,378,386	14,580	122.96	46
2017Q3	2,955,271	14,681	132.76	47
2017Q4	1,557,819	14,772	112.47	48
2018Q1	2,710,630	14,928	117.88	49
2018Q2	1,884,180	15,061	125.61	50
2018Q3	2,585,081	15,220	116.72	51
2018Q4	3,410,664	15,365	110.82	52
2019Q1	3,916,377	15,541	115.32	53
2019Q2	3,426,818	15,530	125.27	54
2019Q3	2,855,114	15,637	118.79	55
2019Q4	1,395,547	15,727	108.16	56
2020Q1	2,822,342	15,822	114.88	57
2020Q2	2,000,491	17,385	118.32	58
2020Q3	2,385,768	16,775	105.79	59
2020Q4	1,992,949	16,445	101.74	60
2021Q1	2,230,593	18,381	108.18	61
2021Q2	1,723,002	16,956	112.98	62
2021Q3	2,730,055	16,730	120.76	63
2021Q4	1,435,963	16,488	123.51	64
2022Q1	2,325,533	16,067	132.36	65
2022Q2	2,389,491	16,010	139.25	66
2022Q3	1,739,112	16,152	141.93	67
2022Q4	1,268,780	16,239	143.42	68
2023Q1	3,003,172	16,663	152.99	69
2023Q2	2,214,691	16,797	160.92	70
2023Q3	2,706,047	16,820	179.02	71
2023Q4	1,307,875	16,911	184.27	72

Panel Data Used in Import Demand Models

COUNTRY/ REGION	YEAR	EXPORT PROMOTION $	COVID-19 0 OR 1	CPI ALL ITEMS 2015=100	REAL EXCHANGE RATE	FAS EXPORT PROMOTION $
Japan	2006	2,011,146	0	97.2	101.8	2,223,371
Japan	2007	1,825,551	0	97.2	106.0	7,809,024
Japan	2008	2,058,151	0	98.6	95.2	4,303,259
Japan	2009	1,476,171	0	97.2	87.1	5,435,455
Japan	2010	1,487,774	0	96.5	83.7	5,433,293
Japan	2011	1,564,961	0	96.3	78.7	5,074,763
Japan	2012	1,620,074	0	96.2	80.3	3,707,884
Japan	2013	2,556,366	0	96.5	99.4	3,057,422
Japan	2014	2,532,502	0	99.2	106.7	2,671,426
Japan	2015	2,615,645	0	100.0	121.0	3,589,927
Japan	2016	2,879,835	0	99.9	110.3	4,434,433
Japan	2017	2,369,792	0	100.4	115.6	2,948,504
Japan	2018	2,410,097	0	101.3	115.4	2,873,970
Japan	2019	3,163,560	0	101.8	115.5	4,096,570
Japan	2020	3,062,654	1	101.8	114.6	2,653,208
Japan	2021	3,095,284	1	101.6	123.6	3,281,542
Japan	2022	3,133,232	1	104.1	155.8	3,141,301
Japan	2023	2,830,194	1	107.1	159.7	3,120,292
Korea	2006	541,216	0	80.2	1,012.4	898,080
Korea	2007	925,434	0	82.2	988.6	809,418
Korea	2008	866,380	0	86.1	1,162.8	1,047,923
Korea	2009	1,295,758	0	88.5	1,307.0	1,520,626
Korea	2010	1,424,137	0	91.1	1,168.3	1,724,856
Korea	2011	1,239,714	0	94.7	1,110.5	1,306,103
Korea	2012	1,411,414	0	96.8	1,127.4	5,420,662
Korea	2013	1,268,235	0	98.0	1,097.6	1,862,991
Korea	2014	1,056,653	0	99.3	1,059.1	1,949,378
Korea	2015	1,056,402	0	100.0	1,131.2	2,728,544
Korea	2016	1,125,290	0	101.0	1,163.8	2,129,108
Korea	2017	970,979	0	102.9	1,135.8	1,899,836
Korea	2018	995,847	0	104.5	1,116.3	654,396
Korea	2019	897,937	0	104.9	1,198.6	2,604,826
Korea	2020	893,895	1	105.4	1,222.8	2,607,895
Korea	2021	944,129	1	108.1	1,210.7	2,937,944
Korea	2022	1,069,102	1	113.5	1,405.0	2,998,871
Korea	2023	1,149,335	1	117.2	1,417.9	2,701,055
Taiwan	2006	263,095	0	90.2	30.7	644,561
Taiwan	2007	376,812	0	91.8	31.3	848,399
Taiwan	2008	374,905	0	95.0	30.1	718,088
Taiwan	2009	452,038	0	94.2	31.8	817,710
Taiwan	2010	581,779	0	95.1	30.6	886,154
Taiwan	2011	595,831	0	96.5	29.0	712,678
Taiwan	2012	548,857	0	98.3	29.2	813,026
Taiwan	2013	588,232	0	99.1	29.5	799,723
Taiwan	2014	652,231	0	100.3	30.2	692,810

Taiwan	2015	680,273	0	100.0	31.9	733,302
Taiwan	2016	727,251	0	101.4	32.3	656,426
Taiwan	2017	690,619	0	102.0	30.9	654,181
Taiwan	2018	660,862	0	103.4	30.9	771,224
Taiwan	2019	544,732	0	104.0	32.1	695,292
Taiwan	2020	540,290	1	103.7	31.2	1,154,246
Taiwan	2021	553,786	1	105.8	30.3	757,865
Taiwan	2022	537,125	1	108.9	33.8	976,386
Taiwan	2023	556,375	1	111.0	35.3	696,537
Hong Kong	2006	836	0	74.3	8.9	712,336
Hong Kong	2007	783	0	75.8	9.0	406,461
Hong Kong	2008	1,128	0	79.0	8.9	482,588
Hong Kong	2009	1,263	0	79.5	8.8	557,715
Hong Kong	2010	1,283	0	81.3	8.8	555,413
Hong Kong	2011	1,384	0	85.6	8.6	524,263
Hong Kong	2012	1,484	0	89.1	8.4	624,044
Hong Kong	2013	1,485	0	93.0	8.2	1,034,269
Hong Kong	2014	2,282	0	97.1	8.0	299,461
Hong Kong	2015	2,325	0	100.0	7.8	508,425
Hong Kong	2016	2,706	0	102.4	7.7	904,127
Hong Kong	2017	3,106	0	103.9	7.8	930,173
Hong Kong	2018	3,758	0	106.4	7.8	1,434,553
Hong Kong	2019	2,667	0	109.5	7.7	1,740,495
Hong Kong	2020	2,668	1	109.8	7.7	1,009,933
Hong Kong	2021	3,059	1	111.5	8.0	1,971,793
Hong Kong	2022	1,283	1	113.6	8.5	1,528,007
Hong Kong	2023	2,571	1	116.1	8.7	1,972,720
EU27 External Trade (Brexit)	2006	57,112	0	86.6	86.8	427,084
EU27 External Trade (Brexit)	2007	136,343	0	88.5	79.9	398,744
EU27 External Trade (Brexit)	2008	314,839	0	91.6	75.0	1,147,653
EU27 External Trade (Brexit)	2009	235,302	0	92.0	78.9	356,748
EU27 External Trade (Brexit)	2010	202,352	0	93.4	82.7	536,689
EU27 External Trade (Brexit)	2011	219,547	0	95.9	79.1	586,529
EU27 External Trade (Brexit)	2012	224,376	0	98.2	85.3	473,755
EU27 External Trade (Brexit)	2013	291,671	0	99.4	82.5	489,566
EU27 External Trade (Brexit)	2014	311,815	0	99.9	83.6	627,178
EU27 External Trade (Brexit)	2015	337,808	0	100.0	100.0	353,829
EU27 External Trade (Brexit)	2016	352,784	0	100.2	101.3	665,938
EU27 External Trade (Brexit)	2017	354,695	0	101.7	100.0	397,532
EU27 External Trade (Brexit)	2018	350,034	0	103.4	96.4	437,849
EU27 External Trade (Brexit)	2019	376,635	0	104.8	102.1	476,037
EU27 External Trade (Brexit)	2020	495,741	1	105.3	101.0	763,610
EU27 External Trade (Brexit)	2021	398,607	1	108.2	99.1	773,313
EU27 External Trade (Brexit)	2022	461,377	1	117.7	110.2	1,030,185
EU27 External Trade (Brexit)	2023	386,563	1	124.7	104.2	927,012
Mexico	2006	698,771	0	69.9	13.3	1,624,175
Mexico	2007	702,875	0	72.6	13.2	1,470,168
Mexico	2008	675,454	0	76.4	13.2	1,851,853
Mexico	2009	863,252	0	80.4	15.2	1,715,008

Mexico	2010	870,986	0	83.7	13.9	1,207,426
Mexico	2011	1,073,303	0	86.6	13.6	2,294,835
Mexico	2012	1,159,064	0	90.2	14.1	1,088,554
Mexico	2013	1,138,378	0	93.6	13.4	1,025,606
Mexico	2014	1,181,385	0	97.4	13.6	511,217
Mexico	2015	1,121,749	0	100.0	15.8	1,055,917
Mexico	2016	1,174,186	0	102.8	18.4	1,112,524
Mexico	2017	840,146	0	109.0	18.0	1,177,416
Mexico	2018	917,910	0	114.4	17.8	955,751
Mexico	2019	1,099,730	0	118.5	17.5	739,739
Mexico	2020	1,094,083	1	122.6	19.2	761,628
Mexico	2021	996,496	1	129.5	17.9	1,070,682
Mexico	2022	1,229,241	1	139.8	17.8	1,664,645
Mexico	2023	965,991	1	147.5	16.2	1,517,887
China	2006	157,404	0	76.5	8.9	1
China	2007	147,134	0	80.2	8.3	2,173
China	2008	212,093	0	85.0	7.4	76
China	2009	238,755	0	84.3	7.3	0
China	2010	243,967	0	87.0	7.2	2
China	2011	264,355	0	91.8	6.7	1
China	2012	283,974	0	94.3	6.5	1
China	2013	284,262	0	96.7	6.3	1
China	2014	436,770	0	98.6	6.2	1
China	2015	445,276	0	100.0	6.2	1
China	2016	518,642	0	102.0	6.6	1
China	2017	595,692	0	103.6	6.7	1
China	2018	721,500	0	105.8	6.6	1
China	2019	512,360	0	108.8	6.8	1
China	2020	512,640	1	111.5	6.8	1
China	2021	587,734	1	112.5	6.6	1
China	2022	246,621	1	114.7	7.2	1
China	2023	494,439	1	115.4	7.6	1

Panel Data Used in Import Demand Models

COUNTRY/ REGION	YEAR	GDP BIL 2017 $	ROW BEEF PRICE $/LB.	ROW BEEF IMPORTS KGS.	TREND #	USMEF PROMOTION $
Japan	2006	4,217	4.47	500,426,995	1	1,161,482
Japan	2007	4,286	4.54	480,786,403	2	1,272,830
Japan	2008	4,240	4.91	441,895,537	3	886,509
Japan	2009	4,010	4.17	453,574,988	4	295,745
Japan	2010	4,178	4.64	447,771,654	5	590,057
Japan	2011	4,173	5.23	435,346,000	6	959,402
Japan	2012	4,236	5.33	418,780,000	7	1,058,784
Japan	2013	4,320	5.06	383,072,000	8	1,590,515
Japan	2014	4,336	5.47	365,558,000	9	2,015,982
Japan	2015	4,389	5.67	365,220,000	10	2,842,493
Japan	2016	4,412	5.71	348,524,000	11	2,822,936
Japan	2017	4,508	5.67	369,465,000	12	2,818,061
Japan	2018	4,523	5.72	398,306,000	13	2,793,603
Japan	2019	4,552	5.92	418,843,000	14	2,121,846
Japan	2020	4,355	5.90	384,874,000	15	1,934,690
Japan	2021	4,453	6.62	394,068,000	16	2,381,852
Japan	2022	4,498	7.10	377,405,000	17	2,030,297
Japan	2023	4,547	6.26	348,451,000	18	2,013,306
Korea	2006	1,075	3.72	236,330,382	1	272,357
Korea	2007	1,137	4.09	230,489,541	2	1,035,990
Korea	2008	1,172	4.27	199,940,027	3	297,684
Korea	2009	1,181	3.15	183,271,025	4	442,957
Korea	2010	1,261	3.84	198,889,660	5	571,380
Korea	2011	1,308	4.75	215,595,000	6	548,570
Korea	2012	1,339	4.60	192,995,000	7	578,852
Korea	2013	1,381	4.84	199,222,000	8	377,994
Korea	2014	1,426	5.32	203,383,000	9	143,100
Korea	2015	1,466	5.59	215,866,000	10	58,145
Korea	2016	1,509	5.32	234,577,000	11	984,262
Korea	2017	1,557	5.38	224,210,000	12	1,551,048
Korea	2018	1,598	5.54	229,632,000	13	1,687,570
Korea	2019	1,631	5.58	233,221,000	14	478,881
Korea	2020	1,619	5.74	227,661,000	15	880,663
Korea	2021	1,686	6.65	245,801,000	16	706,330
Korea	2022	1,730	7.76	242,600,000	17	1,206,431
Korea	2023	1,757	6.54	250,042,000	18	1,828,178
Taiwan	2006	396	3.81	57,847,064	1	171,929
Taiwan	2007	424	3.80	57,505,212	2	82,492
Taiwan	2008	427	4.16	54,643,331	3	-14,937
Taiwan	2009	420	3.50	60,281,390	4	-79,273
Taiwan	2010	463	4.12	61,649,668	5	-28,412
Taiwan	2011	480	5.39	67,337,000	6	-9,870
Taiwan	2012	491	5.50	69,340,000	7	-28,344
Taiwan	2013	503	5.53	65,320,000	8	-89,230
Taiwan	2014	527	5.81	71,385,000	9	-171,221

Taiwan	2015	534	5.70	67,706,000	10	-76,242
Taiwan	2016	546	5.59	73,804,000	11	-13,009
Taiwan	2017	564	6.04	76,169,000	12	6,084
Taiwan	2018	580	6.02	75,777,000	13	79,649
Taiwan	2019	595	5.88	77,304,000	14	194,863
Taiwan	2020	615	6.13	84,227,000	15	226,018
Taiwan	2021	656	6.79	86,060,000	16	293,670
Taiwan	2022	672	7.61	87,433,000	17	264,520
Taiwan	2023	679	6.81	94,450,000	18	338,676
Hong Kong	2006	236	1.79	205,616,926	1	476,442
Hong Kong	2007	252	2.10	233,642,513	2	485,954
Hong Kong	2008	257	2.84	267,653,146	3	578,326
Hong Kong	2009	251	2.71	377,421,083	4	600,539
Hong Kong	2010	268	2.97	320,752,565	5	599,628
Hong Kong	2011	280	3.20	350,150,000	6	800,694
Hong Kong	2012	285	3.13	389,425,000	7	871,396
Hong Kong	2013	294	3.37	589,918,000	8	894,054
Hong Kong	2014	302	3.65	673,146,000	9	1,160,486
Hong Kong	2015	309	3.52	479,796,000	10	1,080,225
Hong Kong	2016	316	3.48	539,994,000	11	1,407,396
Hong Kong	2017	328	3.66	610,861,000	12	1,505,904
Hong Kong	2018	337	3.66	680,857,000	13	1,373,192
Hong Kong	2019	333	3.45	602,614,000	14	1,223,995
Hong Kong	2020	312	3.53	631,738,000	15	1,443,594
Hong Kong	2021	332	3.95	537,754,000	16	1,339,720
Hong Kong	2022	320	4.13	302,734,000	17	966,436
Hong Kong	2023	337	3.82	283,671,000	18	1,055,487
EU27 External Trade (Brexit)	2006	12,690	4.77	420,738,000	1	377,741
EU27 External Trade (Brexit)	2007	13,090	6.35	367,194,000	2	523,346
EU27 External Trade (Brexit)	2008	13,173	8.34	279,725,000	3	770,337
EU27 External Trade (Brexit)	2009	12,599	6.65	312,554,000	4	512,423
EU27 External Trade (Brexit)	2010	12,881	6.93	316,737,000	5	327,133
EU27 External Trade (Brexit)	2011	13,124	8.29	312,480,000	6	425,422
EU27 External Trade (Brexit)	2012	13,030	8.02	287,594,000	7	489,279
EU27 External Trade (Brexit)	2013	13,025	8.30	282,746,000	8	367,070
EU27 External Trade (Brexit)	2014	13,233	8.66	281,359,000	9	422,687
EU27 External Trade (Brexit)	2015	13,547	8.05	270,927,000	10	534,423
EU27 External Trade (Brexit)	2016	13,825	7.68	292,792,000	11	557,052
EU27 External Trade (Brexit)	2017	14,203	7.95	283,977,000	12	540,984
EU27 External Trade (Brexit)	2018	14,508	7.79	310,863,000	13	486,925
EU27 External Trade (Brexit)	2019	14,728	7.13	322,971,000	14	410,610
EU27 External Trade (Brexit)	2020	13,873	7.25	260,387,000	15	770,054
EU27 External Trade (Brexit)	2021	14,624	8.22	232,869,000	16	999,631
EU27 External Trade (Brexit)	2022	15,153	8.88	274,217,000	17	721,699
EU27 External Trade (Brexit)	2023	15,265	8.90	261,878,000	18	618,134
Mexico	2006	983	2.92	58,857,222	1	464,011
Mexico	2007	1,005	3.11	65,178,794	2	867,974
Mexico	2008	1,017	3.41	55,950,641	3	661,971
Mexico	2009	963	3.03	53,805,236	4	560,731

Mexico	2010	1,012	3.70	48,478,671	5	518,750
Mexico	2011	1,049	4.56	38,887,000	6	443,453
Mexico	2012	1,088	4.78	27,207,000	7	370,621
Mexico	2013	1,102	4.71	23,014,000	8	243,439
Mexico	2014	1,133	5.68	29,020,000	9	195,878
Mexico	2015	1,171	5.71	31,002,000	10	140,266
Mexico	2016	1,205	4.56	29,403,000	11	493,851
Mexico	2017	1,230	4.63	34,100,000	12	476,118
Mexico	2018	1,256	4.89	33,493,000	13	385,506
Mexico	2019	1,255	5.07	33,763,000	14	432,435
Mexico	2020	1,152	4.39	35,965,000	15	324,491
Mexico	2021	1,209	5.49	50,554,000	16	425,489
Mexico	2022	1,246	5.99	50,740,569	17	291,994
Mexico	2023	1,276	6.40	64,089,950	18	667,642
China	2006	4,983	3.52	5,559,632	1	1
China	2007	5,692	2.60	11,091,949	2	1
China	2008	6,241	3.81	7,259,095	3	1
China	2009	6,828	2.99	17,763,544	4	1
China	2010	7,554	3.16	32,857,433	5	1
China	2011	8,276	4.21	26,726,000	6	1
China	2012	8,926	3.99	70,574,000	7	1
China	2013	9,620	4.23	314,437,000	8	1
China	2014	10,334	4.26	317,119,000	9	1
China	2015	11,062	4.83	494,945,000	10	1
China	2016	11,819	4.30	601,397,000	11	1
China	2017	12,640	4.36	713,988,000	12	1
China	2018	13,494	4.56	1,064,201,000	13	1
China	2019	14,318	4.91	1,684,084,000	14	1
China	2020	14,634	4.75	2,115,372,000	15	1
China	2021	15,871	5.10	2,214,825,000	16	1
China	2022	16,348	6.37	2,538,981,000	17	1
China	2023	17,251	4.94	2,612,877,000	18	1

Panel Data Used in Import Demand Models

COUNTRY/ REGION	YEAR	TOTAL US PROMOTION $	US BEEF PRICE $/LB.	US BEEF IMPORTS KGS.	US BEEF IMPORTS
Japan	2006	5,395,999	6.85	8,384,920	8,384,920
Japan	2007	10,907,405	6.34	39,978,110	39,978,110
Japan	2008	7,247,919	6.42	61,271,139	61,271,139
Japan	2009	7,207,371	5.97	78,915,795	78,915,795
Japan	2010	7,511,124	5.91	105,517,357	105,517,357
Japan	2011	7,599,126	6.24	137,792,000	137,792,000
Japan	2012	6,386,742	7.02	148,279,000	148,279,000
Japan	2013	7,204,303	6.25	216,850,000	216,850,000
Japan	2014	7,219,910	6.80	221,739,000	221,739,000
Japan	2015	9,048,065	6.74	198,504,000	198,504,000
Japan	2016	10,137,204	6.46	230,049,000	230,049,000
Japan	2017	8,136,357	6.59	282,001,000	282,001,000
Japan	2018	8,077,670	6.99	291,315,000	291,315,000
Japan	2019	9,381,976	7.03	286,107,000	286,107,000
Japan	2020	7,650,552	6.70	301,861,000	301,861,000
Japan	2021	8,758,678	8.27	277,177,000	277,177,000
Japan	2022	8,304,830	8.51	270,946,000	270,946,000
Japan	2023	7,963,792	7.63	250,162,000	250,162,000
Korea	2006	1,711,654	3.81	7,972	7,972
Korea	2007	2,770,843	6.66	14,112,009	14,112,009
Korea	2008	2,211,988	6.07	32,446,069	32,446,069
Korea	2009	3,259,342	4.64	61,526,548	61,526,548
Korea	2010	3,720,373	4.55	92,649,437	92,649,437
Korea	2011	3,094,387	5.08	128,445,000	128,445,000
Korea	2012	7,410,928	4.94	105,792,000	105,792,000
Korea	2013	3,509,220	5.70	101,414,000	101,414,000
Korea	2014	3,149,131	6.85	111,629,000	111,629,000
Korea	2015	3,843,091	6.95	115,439,000	115,439,000
Korea	2016	4,238,661	6.14	168,585,000	168,585,000
Korea	2017	4,421,863	6.61	189,880,000	189,880,000
Korea	2018	3,337,813	7.30	224,186,000	224,186,000
Korea	2019	3,981,644	7.38	247,554,000	247,554,000
Korea	2020	4,382,453	7.14	254,117,000	254,117,000
Korea	2021	4,588,403	8.39	259,031,000	259,031,000
Korea	2022	5,274,404	9.91	264,735,000	264,735,000
Korea	2023	5,678,568	8.67	254,924,000	254,924,000
Taiwan	2006	1,079,586	5.24	19,295,532	19,295,532
Taiwan	2007	1,307,703	5.65	18,259,887	18,259,887
Taiwan	2008	1,078,056	6.05	22,572,290	22,572,290
Taiwan	2009	1,190,474	5.77	23,807,209	23,807,209
Taiwan	2010	1,439,520	6.16	35,657,887	35,657,887
Taiwan	2011	1,298,639	6.51	29,788,000	29,788,000
Taiwan	2012	1,333,539	6.80	18,027,000	18,027,000
Taiwan	2013	1,298,725	8.05	33,133,000	33,133,000
Taiwan	2014	1,173,820	8.79	33,446,000	33,446,000

Taiwan	2015	1,337,333	9.34	35,250,000	35,250,000
Taiwan	2016	1,370,668	8.45	43,133,000	43,133,000
Taiwan	2017	1,350,884	9.43	45,450,000	45,450,000
Taiwan	2018	1,511,735	9.54	57,303,000	57,303,000
Taiwan	2019	1,434,887	9.10	64,390,000	64,390,000
Taiwan	2020	1,920,554	8.89	64,320,000	64,320,000
Taiwan	2021	1,605,321	10.93	57,339,000	57,339,000
Taiwan	2022	1,778,031	12.47	63,029,000	63,029,000
Taiwan	2023	1,591,588	10.53	60,457,000	60,457,000
Hong Kong	2006	1,189,614	8.62	1,849,637	1,849,637
Hong Kong	2007	893,199	4.49	8,246,620	8,246,620
Hong Kong	2008	1,062,041	4.64	11,924,736	11,924,736
Hong Kong	2009	1,159,518	3.45	27,605,618	27,605,618
Hong Kong	2010	1,156,324	3.98	34,951,314	34,951,314
Hong Kong	2011	1,326,341	4.85	49,955,000	49,955,000
Hong Kong	2012	1,496,924	5.19	62,913,000	62,913,000
Hong Kong	2013	1,929,808	5.68	132,936,000	132,936,000
Hong Kong	2014	1,462,229	6.26	153,816,000	153,816,000
Hong Kong	2015	1,590,975	6.59	122,911,000	122,911,000
Hong Kong	2016	2,314,229	5.94	122,119,000	122,119,000
Hong Kong	2017	2,439,183	6.39	131,955,000	131,955,000
Hong Kong	2018	2,811,503	7.44	135,898,000	135,898,000
Hong Kong	2019	2,967,157	7.88	103,930,000	103,930,000
Hong Kong	2020	2,456,195	7.78	87,956,000	87,956,000
Hong Kong	2021	3,314,572	9.79	55,460,000	55,460,000
Hong Kong	2022	2,495,726	11.63	32,237,000	32,237,000
Hong Kong	2023	3,030,778	10.84	36,864,000	36,864,000
EU27 External Trade (Brexit)	2006	861,937	5.96	1,300,000	1,300,000
EU27 External Trade (Brexit)	2007	1,058,433	11.06	2,107,000	2,107,000
EU27 External Trade (Brexit)	2008	2,232,829	10.44	4,976,000	4,976,000
EU27 External Trade (Brexit)	2009	1,104,473	9.06	7,413,000	7,413,000
EU27 External Trade (Brexit)	2010	1,066,174	9.48	11,757,000	11,757,000
EU27 External Trade (Brexit)	2011	1,231,498	11.48	16,196,000	16,196,000
EU27 External Trade (Brexit)	2012	1,187,410	12.53	16,303,000	16,303,000
EU27 External Trade (Brexit)	2013	1,148,307	12.55	17,276,000	17,276,000
EU27 External Trade (Brexit)	2014	1,361,680	13.33	18,000,000	18,000,000
EU27 External Trade (Brexit)	2015	1,226,060	14.52	18,658,000	18,658,000
EU27 External Trade (Brexit)	2016	1,575,773	13.14	15,799,000	15,799,000
EU27 External Trade (Brexit)	2017	1,293,211	12.26	16,825,000	16,825,000
EU27 External Trade (Brexit)	2018	1,274,808	12.69	15,020,000	15,020,000
EU27 External Trade (Brexit)	2019	1,263,282	13.10	13,161,000	13,161,000
EU27 External Trade (Brexit)	2020	2,029,405	13.68	12,891,000	12,891,000
EU27 External Trade (Brexit)	2021	2,171,551	15.79	11,681,000	11,681,000
EU27 External Trade (Brexit)	2022	2,213,261	16.62	13,507,000	13,507,000
EU27 External Trade (Brexit)	2023	1,931,709	18.13	14,324,000	14,324,000
Mexico	2006	2,786,957	3.32	296,257,606	296,257,606
Mexico	2007	3,041,017	3.52	307,369,706	307,369,706
Mexico	2008	3,189,277	3.85	312,072,467	312,072,467
Mexico	2009	3,138,991	3.33	250,906,861	250,906,861

Mexico	2010	2,597,161	3.77	235,373,558	235,373,558
Mexico	2011	3,811,591	4.57	212,414,000	212,414,000
Mexico	2012	2,618,238	4.93	183,926,000	183,926,000
Mexico	2013	2,407,423	4.97	201,833,000	201,833,000
Mexico	2014	1,888,480	5.94	171,594,000	171,594,000
Mexico	2015	2,317,932	6.17	146,931,000	146,931,000
Mexico	2016	2,780,561	4.80	161,044,000	161,044,000
Mexico	2017	2,493,680	5.06	162,480,000	162,480,000
Mexico	2018	2,259,167	5.31	165,595,000	165,595,000
Mexico	2019	2,271,904	5.52	163,191,000	163,191,000
Mexico	2020	2,180,202	5.53	131,676,000	131,676,000
Mexico	2021	2,492,667	7.58	124,897,000	124,897,000
Mexico	2022	3,185,880	7.15	121,977,531	121,977,531
Mexico	2023	3,151,520	8.02	139,231,764	139,231,764
China	2006	157,406	8.62	100	100
China	2007	149,308	1.10	44,086	44,086
China	2008	212,170	11.93	1,876	1,876
China	2009	238,756	3.45	100	100
China	2010	243,970	3.35	134	134
China	2011	264,357	3.57	169	169
China	2012	283,976	4.18	208	208
China	2013	284,264	15.00	100	100
China	2014	436,772	15.00	100	100
China	2015	445,278	8.79	2,000	2,000
China	2016	518,644	8.08	4,000	4,000
China	2017	595,694	11.30	2,216,000	2,216,000
China	2018	721,502	9.08	6,980,000	6,980,000
China	2019	512,362	8.47	10,008,000	10,008,000
China	2020	512,642	7.84	29,692,000	29,692,000
China	2021	587,736	8.92	150,713,000	150,713,000
China	2022	246,623	9.44	192,264,000	192,264,000
China	2023	494,441	9.18	165,833,000	165,833,000