Assessing Economic Impact That Would Follow Loss of U.S. Beef Exports & Imports

Report prepared for Kansas Beef Council, Oklahoma Beef Council, and Texas Beef Council

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Table of Contents

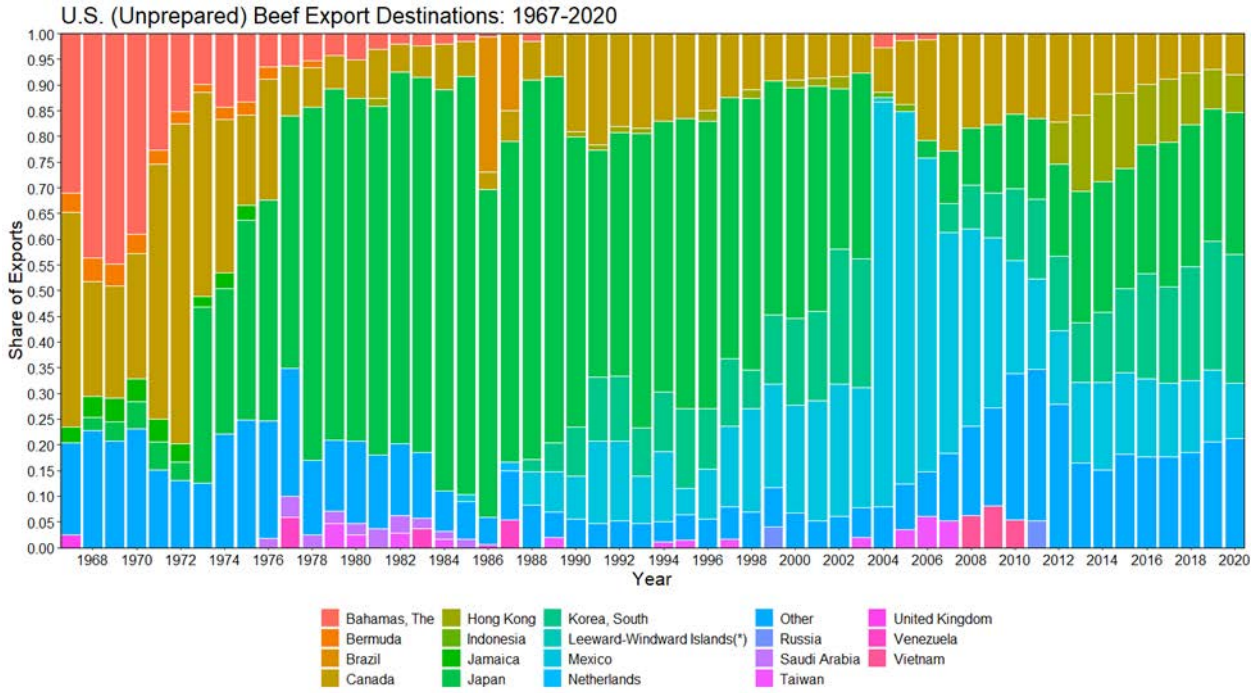
I. Executive Summary

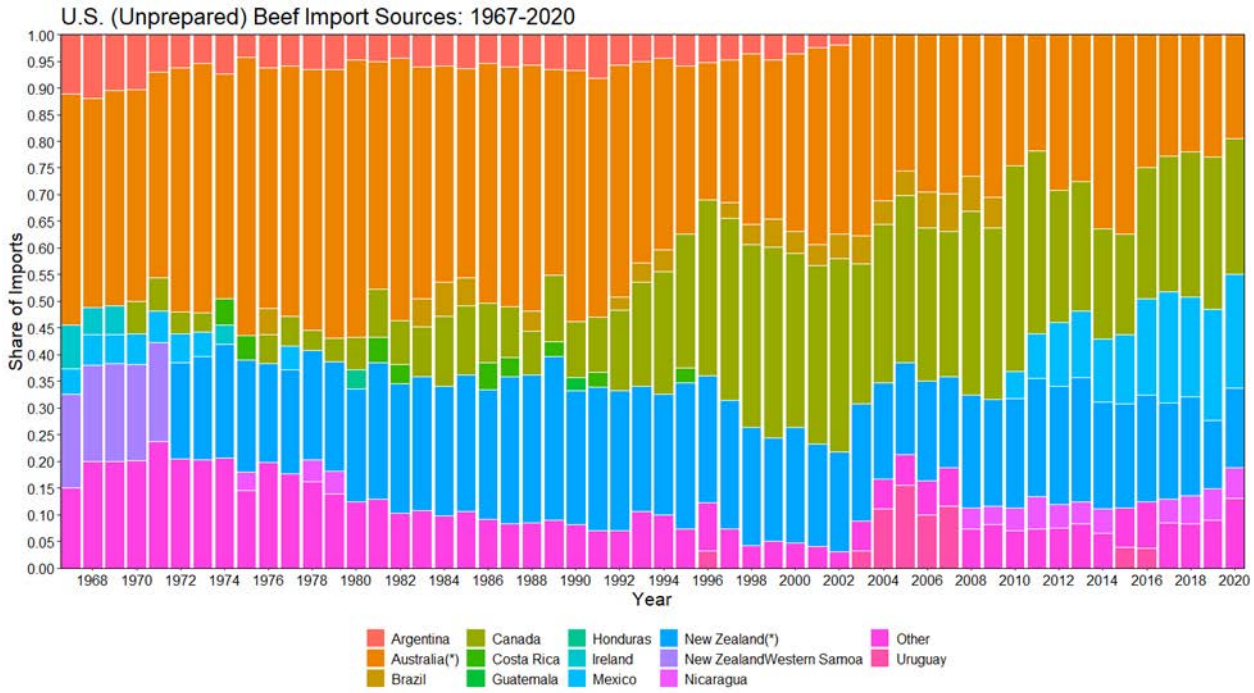
This report summarizes a focused effort by Drs. Tonsor and Peel to assess the economic impact that would follow ceasing both U.S. beef exports and imports. The study focuses on beef trade enabling a deeper and achievable assessment, leaving trade of cattle, hides, and other aspects of the broader industry to other projects. This project outlines why the U.S. trades beef internationally, summarizes historical beef trade data, quantifies national fed and feeder cattle market impacts that could follow loss of beef trade, allocates national impacts to state-level impacts, and provides additional thoughts for future considerations.

Main findings (and some key figures discussed in the full report) include:

- It is hard to over-state the complex and ever-growing role of beef exports and imports. Exports and imports are, to a large extent, conducted by different firms for different reasons precisely because they are mostly different sets of products. Beef exports and imports combine to provide opportunities to increase value to the U.S. industry by exporting products that have more value in foreign markets and importing products that can be sourced more economically in international markets.

- The mix of countries the U.S. exports beef to has developed resulting in a more diverse, less concentrated export portfolio. Conversely, sources of U.S. beef imports have comparatively fluctuated less over time.

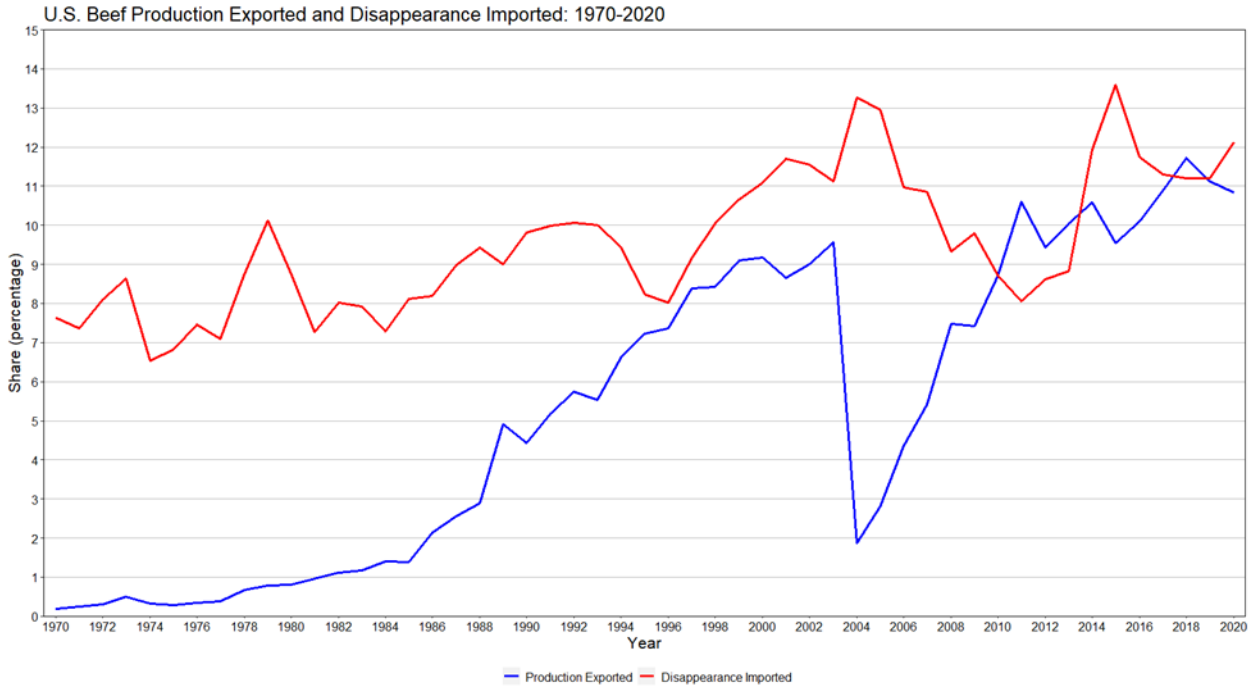




Implied trade prices clearly show the U.S. receives a higher $/lb. value for exports than it pays for imports reflecting core differences in product type and the role of each transaction in adding economic value. From 2016 through 2020, the U.S. experienced average annual

unprepared beef exports of 2.05 billion pounds, export value of $6.4 billion, and implied export price of $3.13/lb. Conversely, 2016-2020 average annual unprepared beef imports were 2.30 billion pounds, import value was $5.8 billion, and implied import price was $2.52/lb. These statistics clearly indicate participation in the global market provides a net economic gain.

- Export volume as a percentage of domestic production has grown substantially in recent decades while imports as a share of domestic disappearance have varied much less.



- If both U.S. beef exports and imports declined by 10% prices and quantities of feeder cattle and fed cattle would decline significantly. The cumulative, net present value of impacts over 10 years would be an economic loss of $12.9 billion to feeder cattle sellers and $6.8 billion to fed cattle sellers.

- Extrapolating the considered 10% beef trade loss case to a more extreme, full 100% loss scenario would suggest catastrophic impact, broadly approximated at $129 billion for feeder cattle sellers and $68 billion for fed cattle sellers reflecting a much smaller overall industry. While the methods used here are not precise for such extreme situations, the take-home point holds: *entirely ceasing U.S. beef export and import trade would be economically catastrophic*.

As an over-arching summary, the economic importance of beef exports and imports is substantial and growing with time. In the absence of beef trade, the entire industry would shrink significantly. Given persistent misunderstanding and market dynamics in the global marketplace in which the U.S. operates, periodic updated assessments are encouraged. Additional enhancements in trade data quality, timing, and precision are encouraged consistent with ever-growing economic importance of beef trade.

This report focuses on impacts of losing international beef trade on domestic feeder and fed cattle sellers and does not consider spillover impacts on other sectors such as allied industries including input suppliers (row crops, feed, materials, etc.), local labor markets, and agricultural lending. As such, this assessment likely understates the total impact involved with the possibility of losing U.S. international beef trade. Nonetheless, the substantial economic role of beef trade is clearly documented here and worthy of associated appreciation.

II. Process Overview and Report Organization

There is ongoing interest in the economic role of beef exports and imports in the U.S. beef-cattle industry. Questions continue to arise regarding what economic impact beef trade has on the industry and the corollary, what impact would follow if beef exports and imports ceased. The project's central objective is to document the historical role of beef exports and imports in the U.S. industry and to quantify the economic impact that could follow from ceasing beef exports and imports.

This report reflects completion of four sequential steps consisting of both qualitative and quantitative components reflecting data availability and the state of knowledge available for this project.

- *Step 1* documents trends in beef trade. This provides baseline context and historical insight in the relative magnitudes of beef exports and imports. This also provides jargon-free insight into "why we trade" and documents diversity in product and trading-partner details as supported by available data.
- *Step 2* uses existing equilibrium displacement models (EDM) to quantify the price and quantity impacts that may follow if beef exports and imports were lost.
- *Step 3* takes estimated national feeder cattle and fed cattle sector impacts and allocates them to specific U.S. states given historical prevalence of beef cows and fed cattle inventories.
- *Step 4* outlines additional points for consideration.

The remainder of this report is comprised of chapters containing information corresponding to these sequential steps and procedures.

III. Why Trade Beef Internationally?

Though international trade is often viewed as something different, there is no fundamental difference in exporting and importing and any other trading activity in an economy. At its core, market activity, buying and selling (including international trade), is about seeking value and allocating resources efficiently. Individuals and companies seek to buy the products they need/want from the most economical source and sell products where they generate the most value. International trade is no different. It is also important to remember that while governments play a critical role in determining if (political access) and how (food safety and other regulations) trade will occur, it is individual companies that trade and for the most part they trade in specific, limited sets of products. In the case of international trade, two governments are involved in determining access and the rules under which trade may occur. The attention that trade policies and agreements receive may explain why international trade is perceived differently than other market activity, but the underlying economics of trade are no different than any other market.

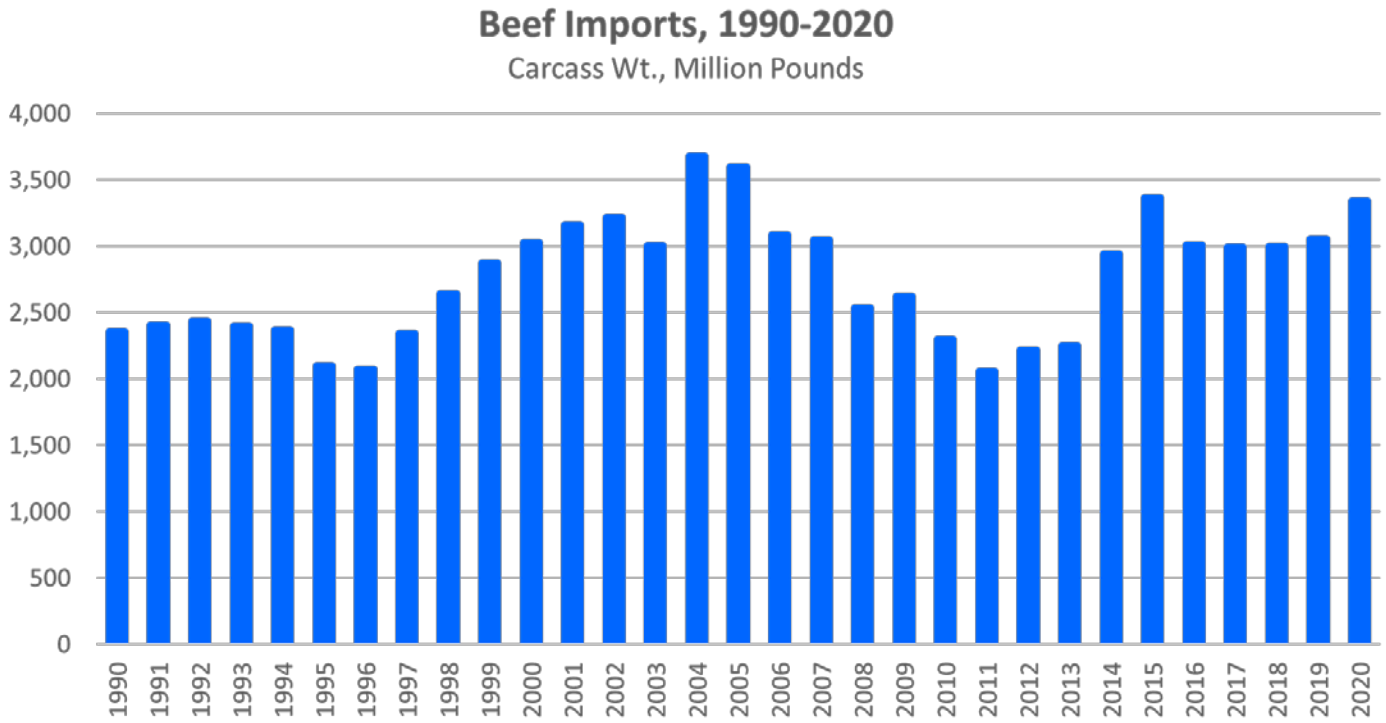
The U.S. is both a major exporter and importer of beef. Other than the basic principle of trade reciprocity, which says that we should not expect to be able to export if we do not allow imports, beef exports and imports are unrelated. Exports and imports are, to a large extent, conducted by different firms for different reasons and precisely because they are mostly different sets of products.

The U.S. has long imported significant volumes of beef products. Despite this, there remains significant confusion on the role of imports. Accordingly, the remainder of this chapter is largely focused on further documenting import patterns with an elevated focus on product- and country-specific insights that can be ascertained from available data. The subsequent chapter

extends this discussion including more insights on exports, relative prices of exports and imports, and other details ascertainable from available data.

Figure 1 shows total annual beef imports since 1990. In the past 20 years, annual beef imports have averaged 2.925 billion pounds (carcass weight) ranging from a maximum of 3.679 billion pounds in 2004 to a minimum of 2.056 billion pounds in 2011. The five-year average from 2016-2020 was 3.081 billion pounds. For many years prior to 2017, the U.S. was the largest beef importing country before being surpassed by China/Hong Kong as the largest global beef importer.

Figure 1. U.S. Beef Imports, 1990-2020



In order to understand why the U.S., which is the largest beef producing country in the world, consistently imports beef it is necessary to understand both the multitude and diversity of beef products that are produced by the U.S. beef industry as well as the nature of beef demand in the U.S. Cattle are the most complex meat animal and produce several hundred different

products at primary fabrication that ultimately become several thousand beef products moving through very distinct and specialized supply chains (Clark, 2019). Beef demand is not a single economic attribute but is the net combination of consumer demands for a multitude of different beef products each of which is a separate market (Clark, 2019). Inevitably, consumer demands for this vast array of products do not exactly match the diverse set of products that result from beef production. While it is true that fabrication can be changed to adjust the set of beef products somewhat (within primals), every carcass will produce a basic set of primals and products derived from them. This means that beef exports and imports both provide opportunities to increase value to the beef industry by exporting products that have more value in foreign markets and importing products that can be sourced more economically in international markets. This is certainly true for beef imports, which includes a variety of products imported to meet demands for specific beef products.

Companies that import beef products do so for any of several reasons. They import to source specific products that are either not available domestically due to limited supplies, are simply not produced in the U.S., or are more expensive domestically. The biggest driver of beef imports is the ground beef market where imported trim or primals supplement domestic supplies of lean processing beef. Imported beef may also be used in a variety of other processed beef products or marketed as cuts in targeted markets. Beef imports may be used to meet general product requirements (e.g. lean content, for ground beef or other processed products) or may be products sourced specifically from unique origins. This might include, for example, beef cuts from Argentina or Uruguay for South American style restaurants (rodízio or Churrasquería) or Mexican beef cuts in Hispanic targeted retail grocery markets.

Ground Beef Market[1]

Ground beef represents upwards of half of total U.S. beef consumption and plays a singular and uniquely important role in the U.S. beef industry in both retail grocery and food service sectors. In order to produce ground beef, beef trimmings containing both fat and lean muscle are utilized and combined together to form ground beef. Beef trimmings are often categorized by lean-to-fat percentage, where 50 percent trimmings are combined with 90 percent, 85 percent, 81 percent, 75 percent, 73 percent, or 65 percent lean trimmings in order to get the various lean-to-fat combinations as required or specified by retail and food service establishments.

Retail grocery establishments market large quantities of ground beef in a variety of forms and packaging. Ground beef for retail grocery is commonly part of supply chains that specialize in case ready products and processing specifically for grocery. For retail grocery, ground beef is typically made from fresh domestic meat products, frequently sourced from muscles and trimmings from specific primals as supermarkets often market ground beef with carcass references such as ground chuck, ground round, ground sirloin, etc.

Ground beef for food service is typically provided by specialized grinders that utilize a diverse set of inputs including fresh 50 percent (or similar) fatty trimmings, fresh lean trimmings or muscles from fed slaughter, fresh or frozen cow/bull lean trimmings and frozen imported lean trimmings. Margins are razor thin in food service, especially in quick service restaurants (QSRs) that feature dollar menus, etc. and ground beef formulation is subject to intense cost scrutiny. Though there is some potential overlap in input sources for food service and retail grocery ground beef, the resources used for each tend to be largely separate.

[1] This section was adapted from Clark (2019) and Peel (2021).

Ground beef producers must find sources of lean trimmings to grind with 50 percent trim from fed beef production. Lean trim comes from cull cow or bull beef as well as imported lean trimmings from a variety of sources. The ground beef production process is complex and is dependent on a steady supply of trimmings or whole muscle cuts and intense food safety protocols. Based on the specified lean point, fresh 65, 70, 75, 80, 85, and 90 percent lean trim from domestic slaughter facilities may be combined with fresh or frozen imported 80, 85, 90, and 95 percent lean trimmings.

To make the consumer's specified lean/fat percentage point at the lowest expense, the grinder or further processor has to be flexible in the products that they are grinding, based on product availability and price. When trim prices are too high, there are several whole muscle cuts that may be used for ground beef. Chuck Rolls, Clods, and Tenders were often ground prior to the increase in exports of Chuck products which has kept their prices high in recent years. Unless Chuck products are at an unusually low price due to over-supply, it does not usually make financial sense to grind whole Chuck products. More commonly, Round products are ground, including the Knuckle, Gooseneck, Inside Round, and Outside Round. Boneless products from the navel and the Short Plate can also be ground for higher fat level products. However, Short Plate products are popular export products to Asian markets, resulting in a high price point that often does not make financial sense to grind. Grinders are constantly watching market prices to determine which products to grind, choosing between trim and whole muscle cuts. Table 1 provides an example list of potential ground beef ingredients that processors might consider to formulate ground beef that meets specific lean percentages.

Table 1. Ground Beef Ingredient Prices, Mid-December, 2021

Product	IMPS	Price ($/cwt.)	% Lean (est.)
Sirloin Ball-Tip	185B	293.08	90
Eye of Round	171C	291.16	90
Outside Round	171B	286.01	90
Inside Top Round	168	270.44	85
Chuck, Two-Piece	113C	265.88	80
Chuck Clod	114	268.46	85
Bottom Round	170	275.73	90
Fresh 92s		284.68	92
Fresh 90s		274.22	90
Fresh 81s		223.17	81
Fresh 65s		164.76	65
Fresh 50s		101.63	50
Imported 90s		296.00	90
Imported 85s		271.00	85
Imported 80s		257.50	80

In recent years, increased demand by fast food restaurants for fresh only ground beef, left the beef industry scrambling to find enough fresh trim or primals to meet the fresh ground beef demand. Frozen, imported beef trimmings can no longer be used, so domestic fresh sources must be used. To meet a specific lean-to-fat ratio, cuts like the Bottom Round Flat, Gooseneck Round, and Inside Round can be ground whole. In winter months, when cull cow slaughter increases, a larger supply of fresh 90% lean trim is available to utilize instead of whole muscle cuts. In summer months, Round Knuckles, Outside Rounds, and other Round products will be purchased in large quantities during seasonal low prices. However, when lean trim or whole muscle cuts are no longer readily available at a favorable price point, production costs increase as grinders work to find other lean sources from trim or whole muscle cuts.

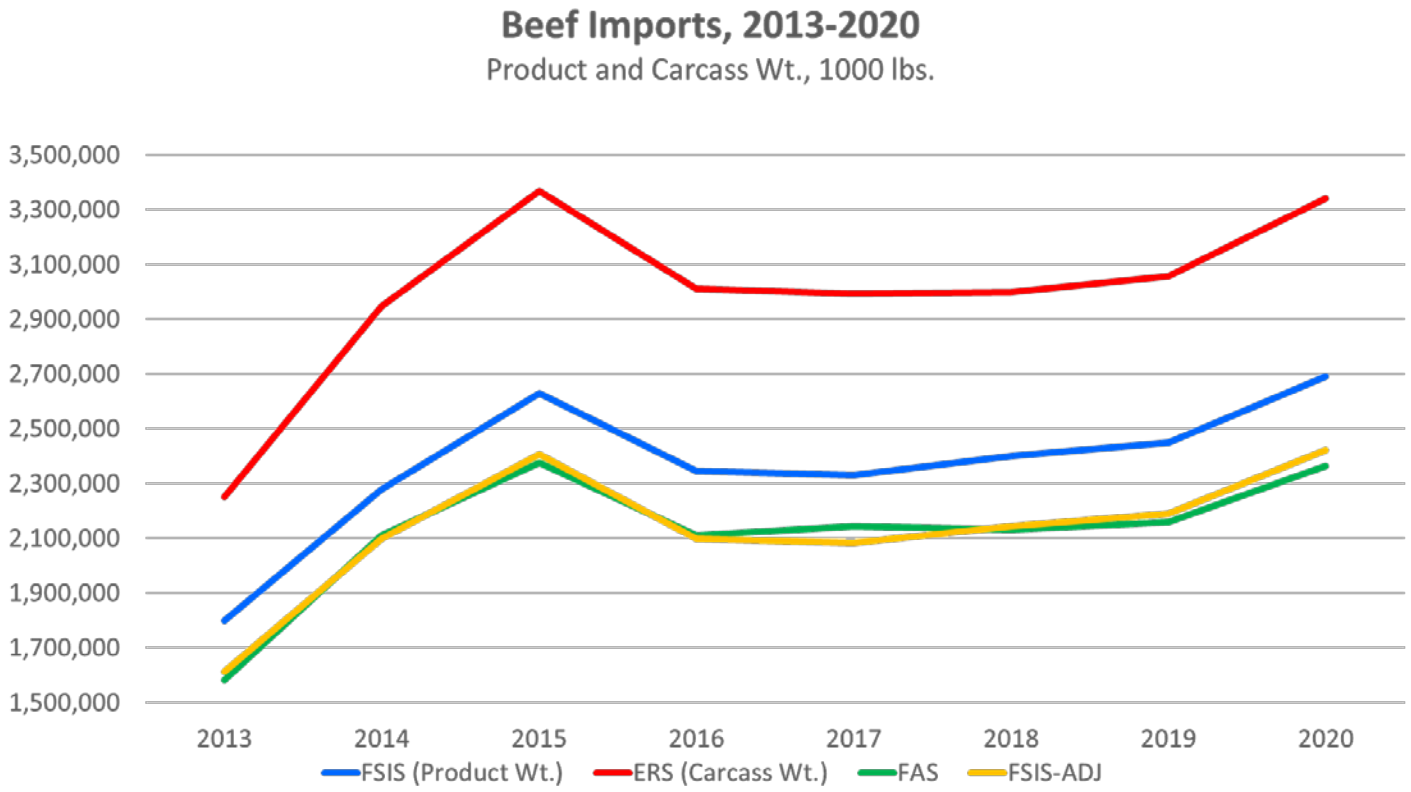
Beef Import Data

There is potential for confusion about beef imports due to the various data sources and aggregations that are available. Following sections will briefly discuss different beef import data sources and how/why they differ.

ERS Beef Import Data

The USDA Economic Research Service (ERS) publishes monthly livestock and meat trade data (https://www.ers.usda.gov/data-products/livestock-and-meat-international-trade-data/). ERS trade data is reported on a carcass weight basis, meaning that direct import product volumes have been adjusted to reflect a carcass equivalent basis. This makes the data more comparable to domestic beef production data (which is also on a carcass basis). Figure 2 plots ERS beef imports for the 2013-2020 period. Since many imports are boneless products, the adjustments to a carcass basis makes the ERS beef import total significantly higher than other data sources.

Figure 2. U.S. Beef Imports, by Data Source



FAS Beef Import Data

The USDA Foreign Agricultural Service (FAS) makes trade data available with the Global Agricultural Trade System on the agency website at https://apps.fas.usda.gov/gats/default.aspx. FAS trade data is product weight with volumes are presented in metric units to be consistent with global trade data. Figure 2 shows FAS beef imports from 2013-2020. The FAS data in Figure 2 includes fresh and frozen bone-in, boneless and carcasses (international harmonized system (HS) codes 2011, 2012, 2013, 2021, 2022 2023). The FAS database includes other categories for offals and dried product, etc.

FSIS Beef Import Data

Inspections by the Food Safety and Inspection Service (USDA-FSIS) provide detailed data beef imports from countries of origin over time (

https://www.fsis.usda.gov/inspection/import-export/international-reports/import-and-export-data). In describing the import volume data provided by the agency, FSIS notes that:

> "Federal law requires every commercial shipment of imported meat, poultry, and egg products to be inspected prior to product entering U.S. commerce. FSIS inspects each shipment to verify labeling, proper certification, general condition, any signs of tampering and to identify product adulterated by transportation damage. FSIS also performs additional activities on a random and/or for-cause basis such as physical product examination and laboratory sampling for pathogens and chemical residues." (USDA-FSIS)

The FSIS import data includes a wide variety of beef products identified by detailed breakdowns of process category, product category, and product group. The FSIS volume data is the primary beef import data and ERS and FAS data are based on the FSIS reported beef import volumes. Most of the beef import summaries in this report are based on FSIS data which are aggregated into five categories designated as: Trim, Cuts, Primals, Offals and Cooked. Table 2 shows examples of the individual data categories (columns 2, 3 and 4) in the FSIS data and the aggregations used in this report (column 1). There are many additional product descriptions in the full data set. Descriptions of the types of data included in the aggregations follows.

Trim – The bulk of this category is labeled as boneless manufacturing trimmings. This category also includes a variety of products listed as ground/comminuted or other otherwise non-intact. Additionally, small amounts of other meat used for manufactured beef products including cheek, head, and heart meat as well as other intact beef. For example, for 2019, the data shows that the trim category includes 86.5 percent boneless manufacturing trimmings along with 10.2 percent

ground/comminuted (non-intact) product and a total of 3.3 percent of cheek, head, heart and other intact meat.

Cuts – This includes products designated as cuts and imported as specific beef muscle cuts.

Primals – This category includes beef products imported as primals/subprimals. This category also includes very small amounts of quarter or half beef carcasses that are occasionally included in imports.

Cooked - This category includes a diverse set of partially or fully cooked products and also includes products that are dried, salted, or acidified/fermented.

Offals – Import data includes edible offals as a separate category which is maintained in this analysis due to the unique specific use of these products.

Table 2. Example Aggregations of FSIS beef import data.

1	2	3	4
	ProcessCategory	**ProductCategory**	**ProductGroup**
TRIM	Raw - Non Intact	Raw ground, comminuted, or otherwise non-intact beef	Advanced Meat Recovery Product (AMR)
TRIM	Raw - Non Intact	Raw ground, comminuted, or otherwise non-intact beef	Beef Patty Product
TRIM	Raw - Non Intact	Raw ground, comminuted, or otherwise non-intact beef	Ground Beef
TRIM	Raw - Non Intact	Raw ground, comminuted, or otherwise non-intact beef	Hamburger
TRIM	Raw – Intact	Raw intact beef	Boneless Manufacturing Trimmings
TRIM	Raw – Intact	Raw intact beef	Cheek Meat
CUTS	Raw – Intact	Raw intact beef	Cuts
OFFALS	Raw – Intact	Raw intact beef	Edible Offal
TRIM	Raw – Intact	Raw intact beef	Head Meat
TRIM	Raw – Intact	Raw intact beef	Other Intact
PRIMALS	Raw – Intact	Raw intact beef	Primals and Subprimals
COOKED	Thermally Processed/Commercially Sterile	Thermally processed, commercially sterile	Other
COOKED	Thermally Processed/Commercially Sterile	Thermally processed, commercially sterile	Soups
COOKED	Not Heat Treated - Shelf Stable	NRTE otherwise processed meat	Other
COOKED	Not Heat Treated - Shelf Stable	NRTE otherwise processed meat	Rendered Fats, Oils
COOKED	Not Heat Treated - Shelf Stable	RTE acidified / fermented meat (without cooking)	Sausage/Salami - Not sliced
COOKED	Heat Treated - Shelf Stable	NRTE otherwise processed meat	Meals/Dinners/Entrees
COOKED	Heat Treated - Shelf Stable	NRTE otherwise processed meat	Other
COOKED	Heat Treated - Shelf Stable	NRTE otherwise processed meat	Pies/Pot Pies

It is apparent that the pattern of beef imports in Figure 2 over time is similar regardless of the data source but vary only in overall level. As noted earlier, the FAS data is only for raw beef products and matches closely with the FSIS when cooked and offal products are removed leaving only the raw products in the cuts, trim and primal/subprimal categories in the FSIS data (FSIS-ADJ in Figure 2). Table 3 shows that the FSIS product weight has averaged 79.3 percent of the ERS data, which is adjusted to a carcass weight basis. However, the table also shows that the adjustment varies across the major import countries because of differences in the composition of products imported from different sources. For example, beef imports from Canada include large amounts of primal/subprimals, which are most similar to U.S. boxed beef and thus require a smaller adjustment compared to imports from Brazil which consist largely of cooked product that requires a large adjustment to a carcass equivalent weight. The relationship between the aggregate ERS and FSIS data across years in Figure 2 is similar but not exactly the same because the mix of imports sources varies across years and because the mix of products imported by country varies somewhat year by year.

Table 3. Beef Import Adjustments for Product Weight to Carcass Weight.

Beef Import Source	FSIS (Product Wt.) as % of ERS (Carcass Wt.), 2016-2020 Average
Australia	76.8
New Zealand	72.9
Canada	89.9
Mexico	83.2
Brazil	53.1
Uruguay	75.1
Total	**79.3**

Beef Import Summary

In the five years from 2016-2020, more than half (51 percent) of beef imports have been processing beef (trim); with 21 percent of imports as primals/subprimals; 18 percent cuts; cooked products at seven percent and edible offals at three percent (Figure 3). Figure 4 shows that while the overall profiles of imports have not changed significantly in recent years, there has been slight increases in proportions of primals and offals with slight decreases in proportions of trim, cuts and cooked products. Figure 5 shows that boneless beef products account for 88.9 percent of beef imports (raw beef, FAS) the last five years (2016-2020), down from 92.7 percent the previous five years (2011-2015). Boneless beef includes all trim product and some primals and cuts. Increased bone-in product imports (primals and cuts) likely reflects recent changes in sources of beef imports and also growing demand for bone-in products (Clark, 2019). Proportions of fresh/chilled beef imports have increased slightly to average 53.0 percent of raw beef imports in the 2016-2020 period, up from 41.6 percent the previous five years (2011-2015) (Figure 6). Frozen beef imports dropped below 50 percent of raw beef imports in 2017. The increase in fresh beef imports is likely related to the recent increase in imports from Canada, from which fresh shipments are more feasible compared to imports from Australia and New Zealand. Figure 7 shows the pattern of average monthly beef imports in 2016-2020 period. Beef imports tend to increase monthly through the first half of the year to a mid-summer peak before declining to the end of the year. The monthly pattern of beef imports reflects both seasonal pattern of beef demand, particularly increased summer grilling demand, as well as domestic patterns of cow slaughter and production of lean beef.

Imported trim makes up just over half of beef imports (Figure 3) and is used primarily for ground beef but also for a variety of other processed beef products including sausage products. Processing beef is also used for numerous prepared products including frozen meals, entrees and

other processed products. Although some processed products will appear in retail grocery supplies as frozen food items, most imported trim is used for food service ground beef or food preparations. Much imported beef trim is frozen and very little imported beef trim is used in retail grocery fresh ground beef formulations.

Figure 3. U.S. Beef Imports, by Product Type

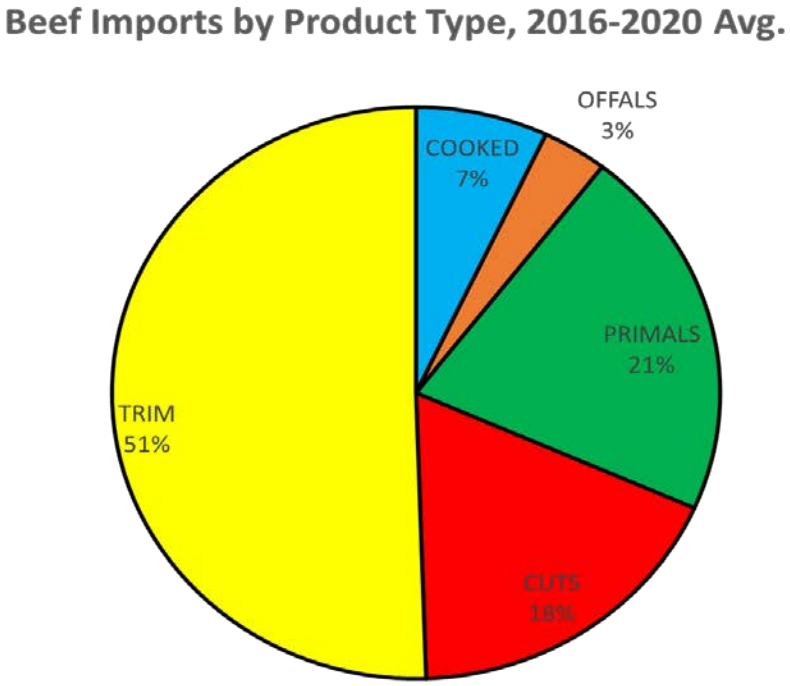


Figure 4. U.S. Beef Imports, by Product Type (2013-2020)

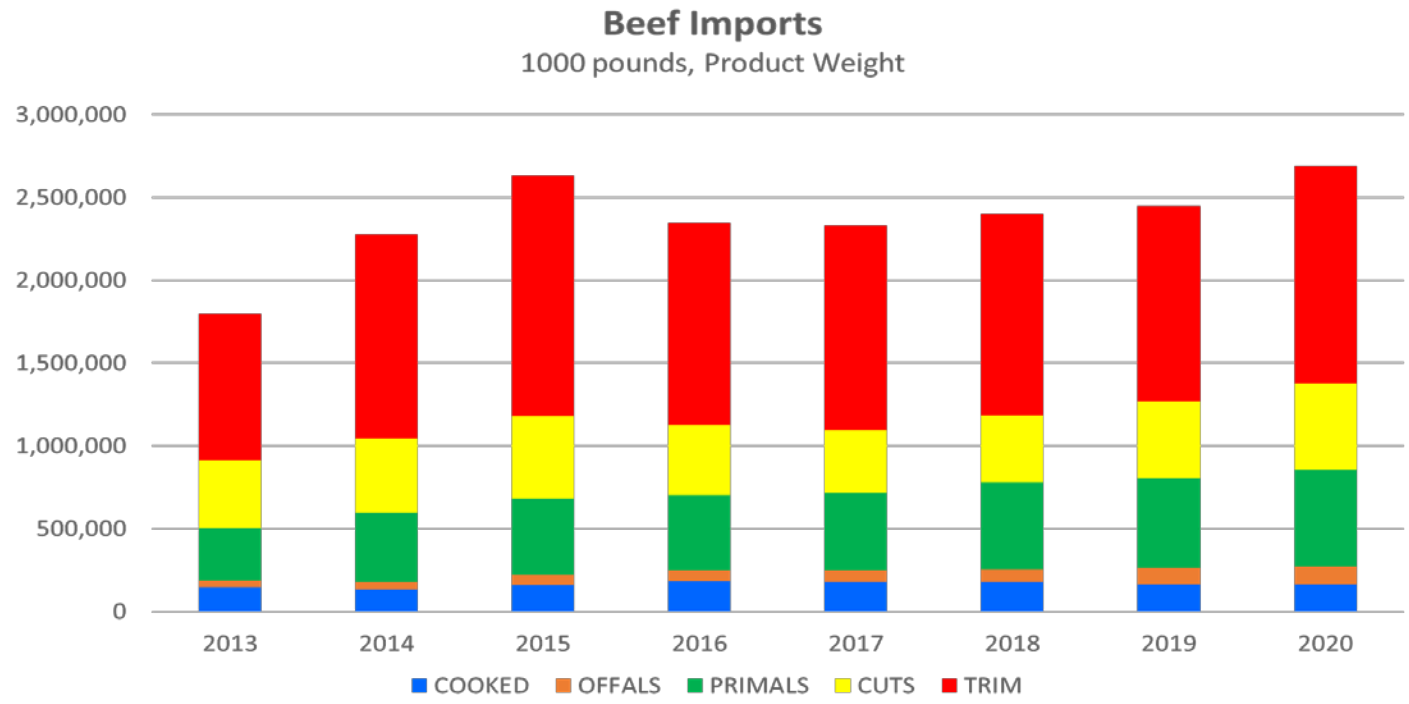


Figure 5. U.S. Beef Imports, Boneless and Bone-In

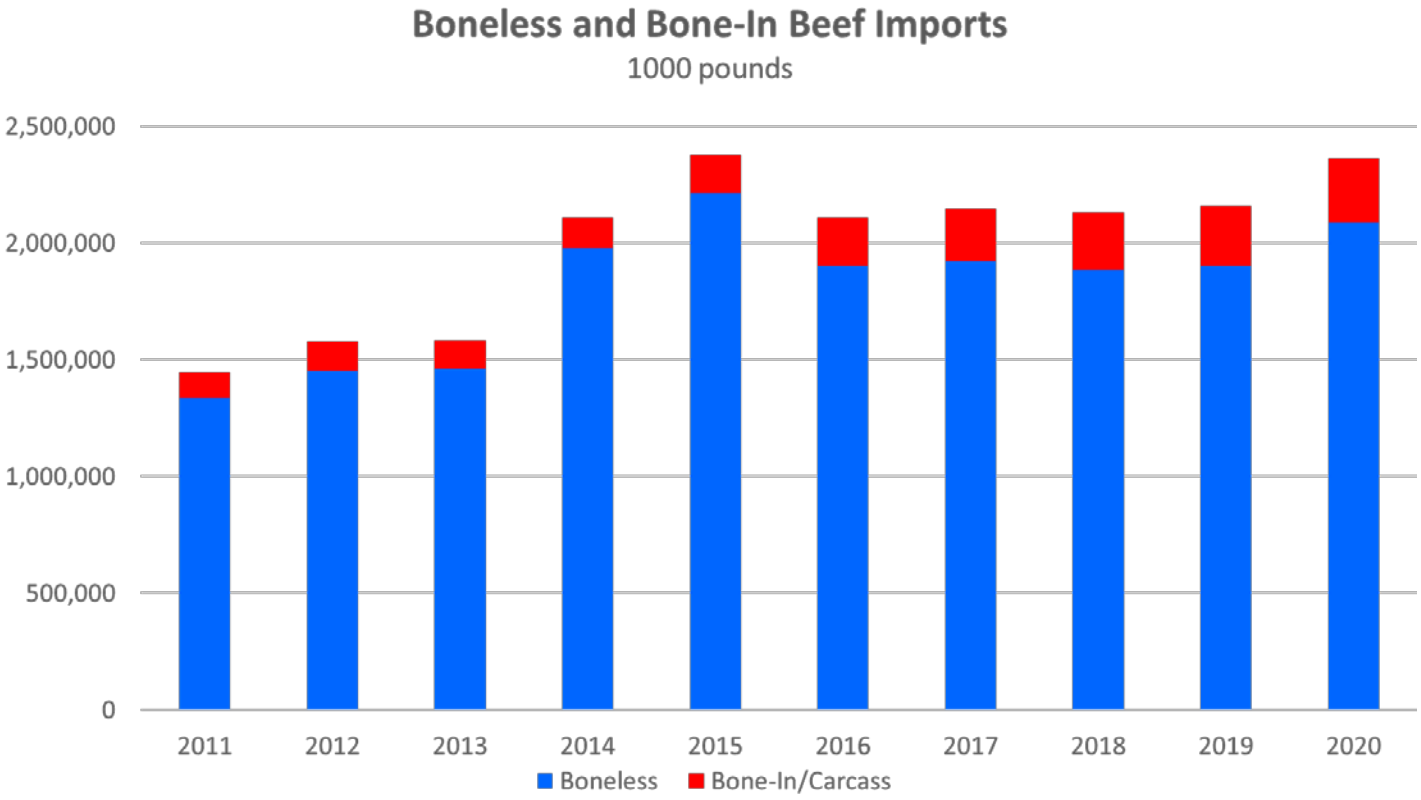


Figure 6. U.S. Beef Imports, Fresh and Frozen

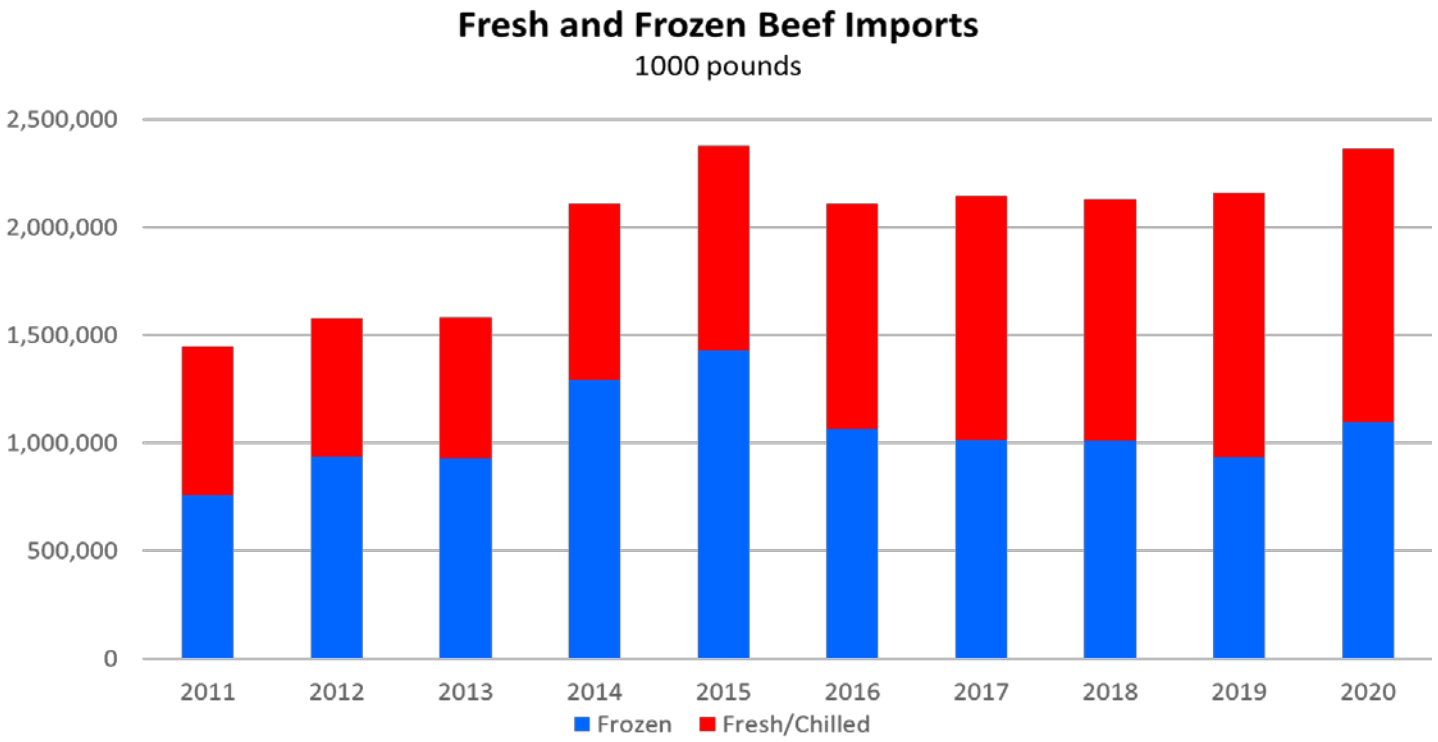
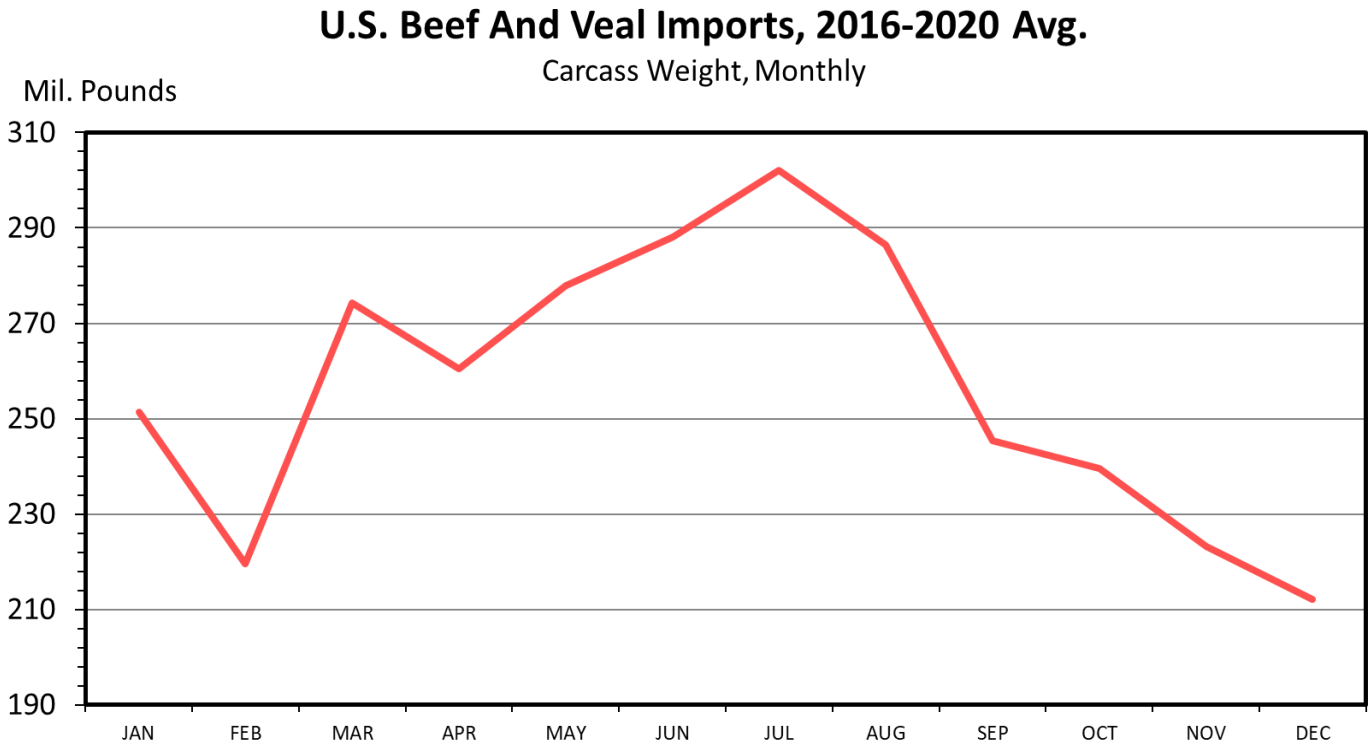


Figure 7. U.S. Beef and Veal Imports



Primals/subprimals made up 21 percent of average beef imports for the 2016-2020 period (Figure 3). Primals and subprimals are very flexible and may be bone-in or boneless, fresh or frozen and may be used for cuts or for processing. For example, an importer may use a loin primal for Strip Loin and Tenderloin cuts or might be purchasing a round subprimal for jerky or for grinding into ground beef. The demand for and use of primals/subprimals is very price sensitive and flexible and is, in many ways, is the mechanism that numerous beef product markets are balanced under dynamic market conditions.

Imports of specific beef cuts make up 18 percent of average beef imports for the 2016-2020 period (Figure 3). Most cuts are imported for use as those cuts and are marketed with little additional fabrication. As we will see, most imported beef cuts are from Mexico and the majority are marketed at retail grocery stores.

Cooked products made up seven percent of beef imports from 2016-2020 (Figure 3). The category of cooked product includes a wide range of products that are fully or partially cooked, dried, salted or acidified/fermented. Cooked products may be imported simply because it is economical/convenient to import them after cooking rather than as raw products or because there are trade restrictions on the import of raw beef products. Imports of cooked product from Canada are an example of the former while imports of cooked product from Brazil is an example of the later.

The FSIS data included imports of edible offals. Although most offals from beef production in the U.S. are exported, there is a small level of imported offals. This is likely due to regional availability/price. Edible offals made up just 3 percent of beef imports on average from 2016-2020 (Figure 3).

Beef Import Origins

Figure 8 show the breakdown of beef imports since 2000 by major import source. The most obvious trend in Figure 8 is the growth in beef imports from Mexico in the past decade. Additionally, beef imports from Canada have increased recently, while imports from Australia have been temporarily reduced due to lower production resulting from fires/drought. In recent years, the four countries of Australia, New Zealand, Canada and Mexico account for roughly 86 percent of beef imports (Figure 9). Most of the remaining portion of beef imports are small amounts from several Central and South American countries. In the past five years from 2016-2020, extremely small amounts of beef imports (<0.5% of total imports) have originated from several other countries including Ireland, Japan, Lithuania, Italy, Namibia, Denmark, Netherlands, France and the U.K.. Beef imports from Ireland have accounted for an average of 84 percent of the total imports from these other minor import sources in the past five years. In 2020, total imports from these minor countries increased to 1.1 percent of total beef imports, including imports from Ireland along with increases from the Netherlands and Namibia.

Figure 8. U.S. Beef Imports, by Country Source (2000-2020)

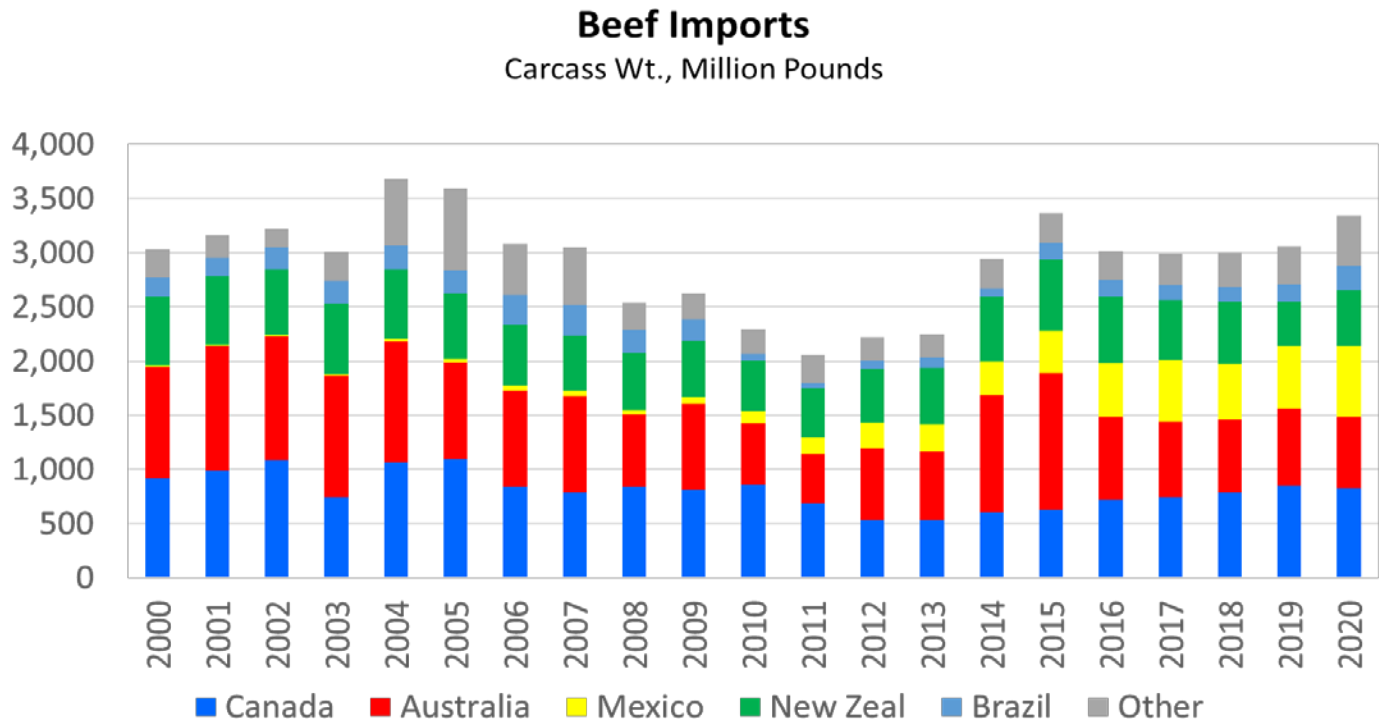


Figure 9. U.S. beef Imports, by Country Source (2016-2020 average)

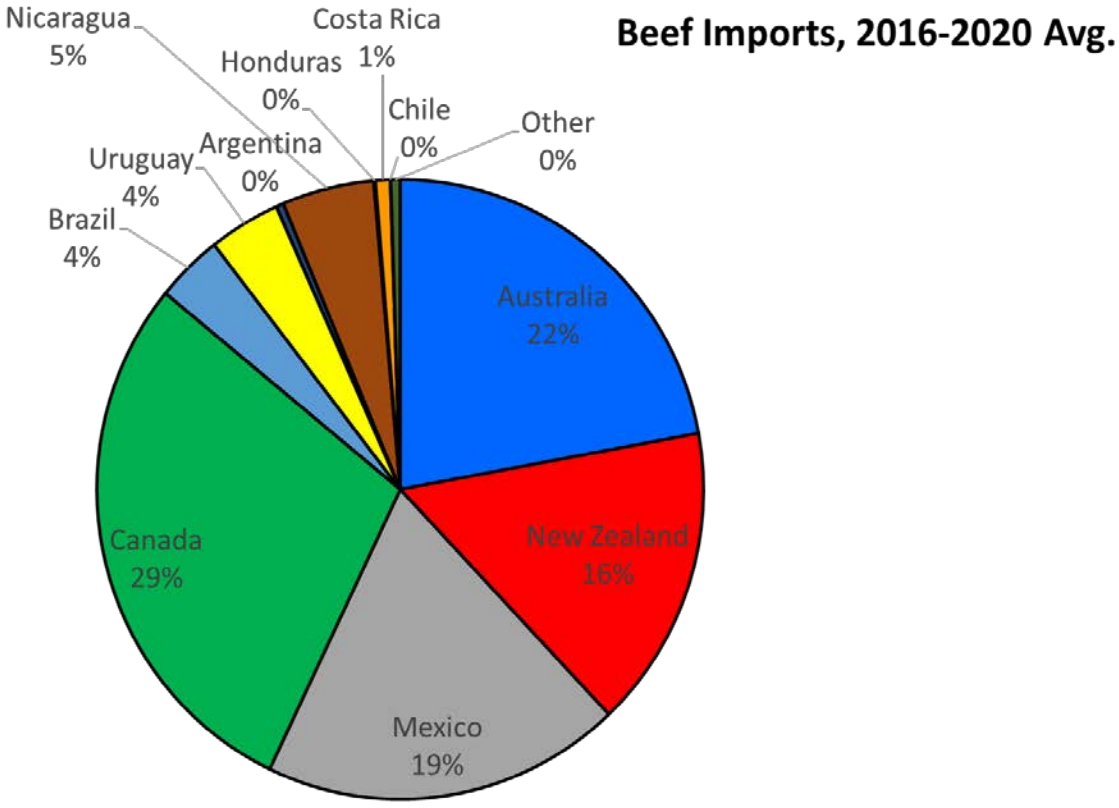


Figure 10 shows average beef imports from 2016-2020 by country and product type. It is very apparent that the types of products imported varies significantly across countries. This highlights the fact that beef imports are specific products imported from specific sources for specific uses. The largest category for beef imports is trim, which has the most diverse set of sources. In recent years, Australia and New Zealand have accounted for over half of trim imports with each representing 27 percent of total trim imports (Figure 11). Canada and Mexico combined for another 30 percent of trim imports and Nicaragua added another 8 percent.

Figure 10. U.S. Beef Imports, by Product Type (2016-2020 average)

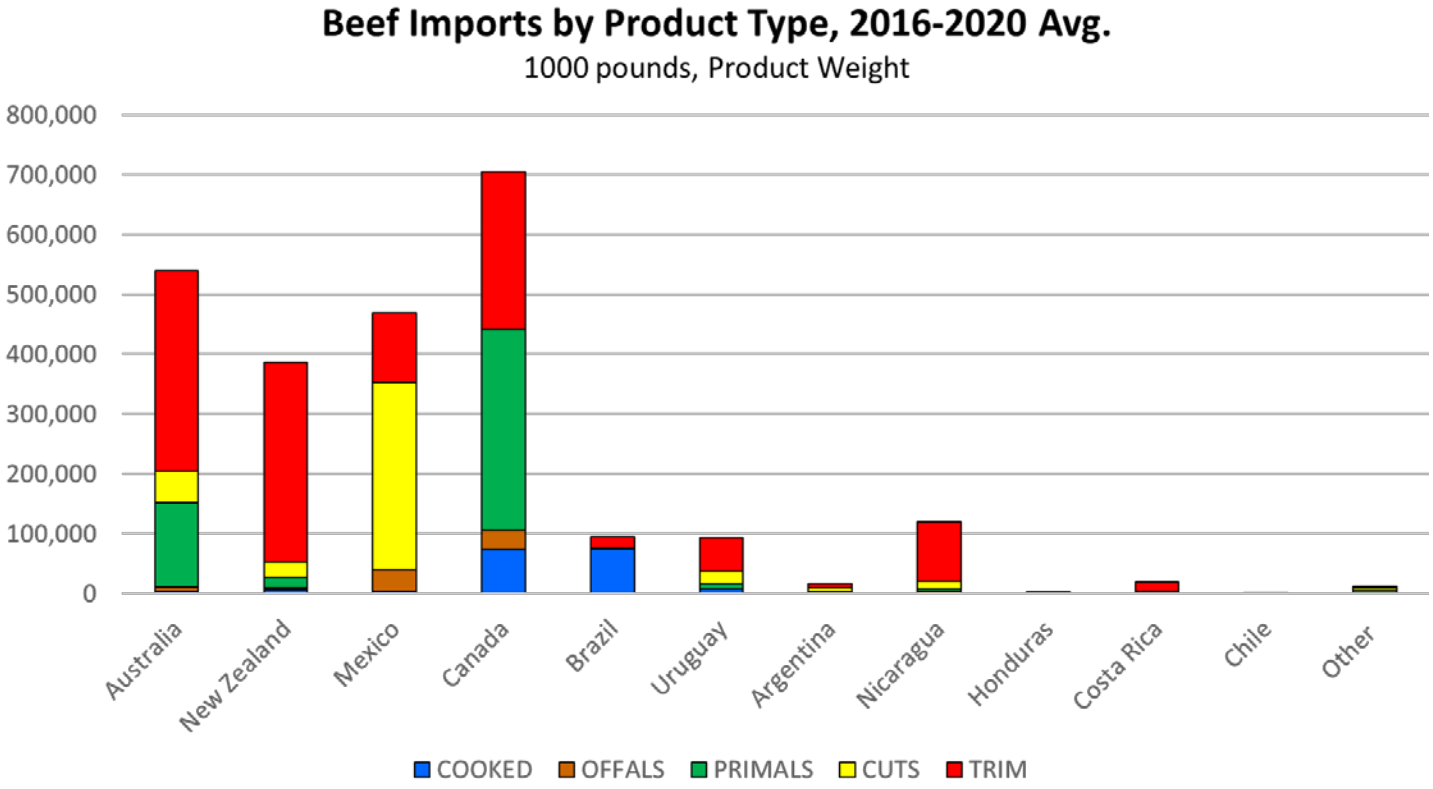
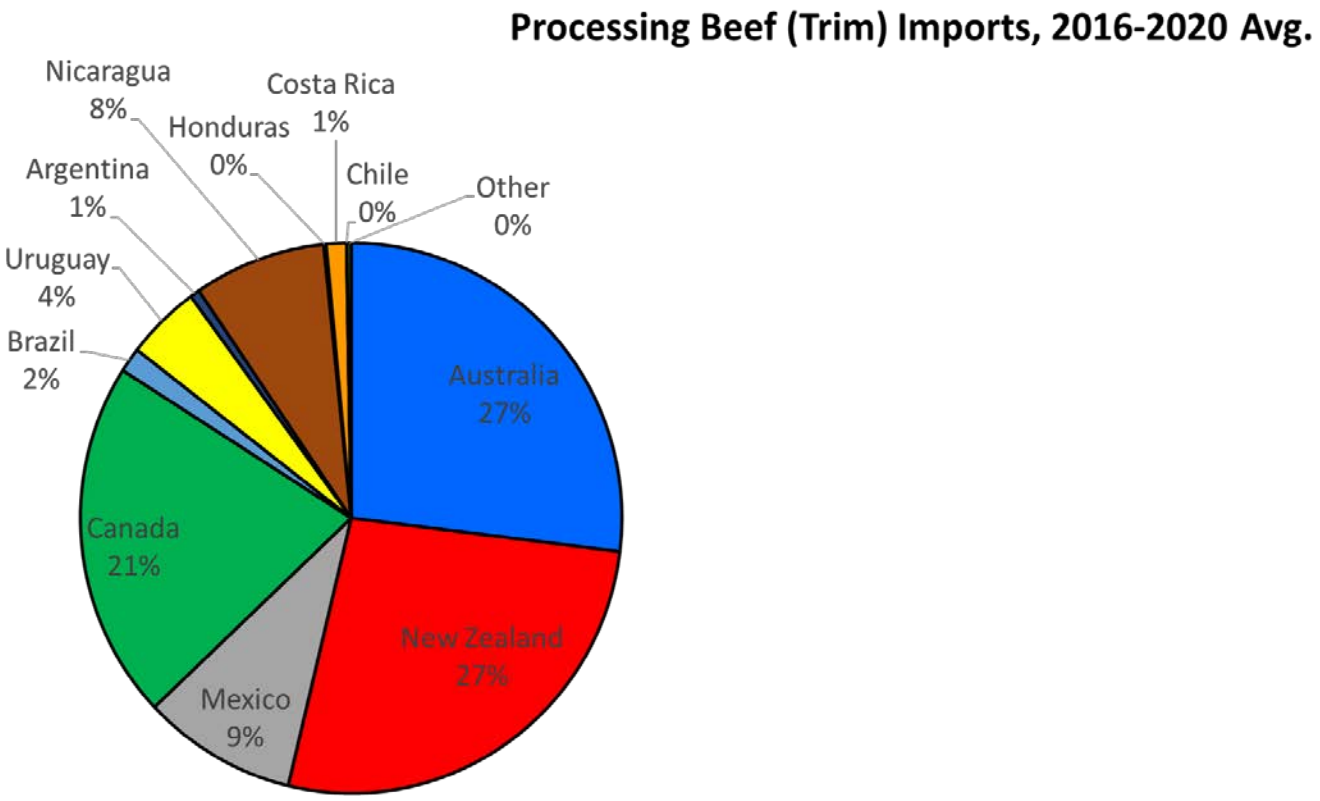


Figure 11. U.S. Beef Imports, Processing Beef (Trim)



Beyond trim, beef imports tend to be quite specialized by country source. Canada accounts for 65 percent of primal imports (Figure 12) with Australia adding another 22 percent. In contrast, imports of beef cuts mostly originate in Mexico, which accounts for 71 percent of imported cuts, along with another 12 percent from Australia (Figure 13). Imports of cooked products is about evenly split between Brazil, which has been limited until recently to cooked products, and Canada (Figure 14). Together these two countries account for 87 percent of cooked beef product imports. Figure 15 shows that beef offals are imported primarily from Mexico and Canada.

Figure 12. U.S. Beef Imports, Primal/Subprimals

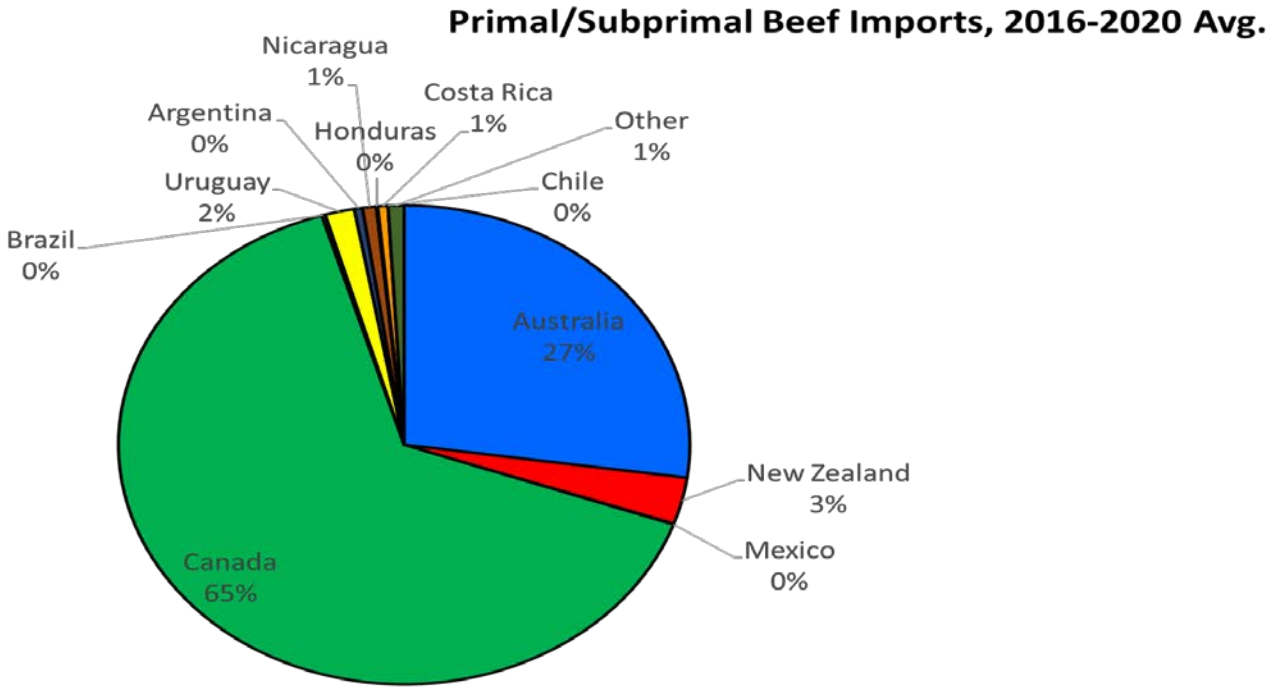
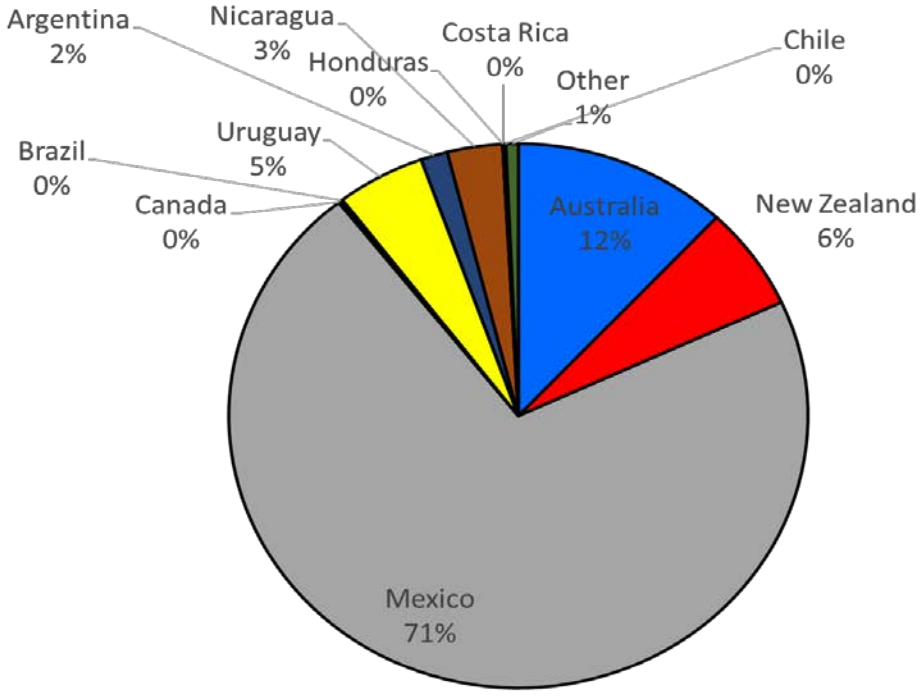
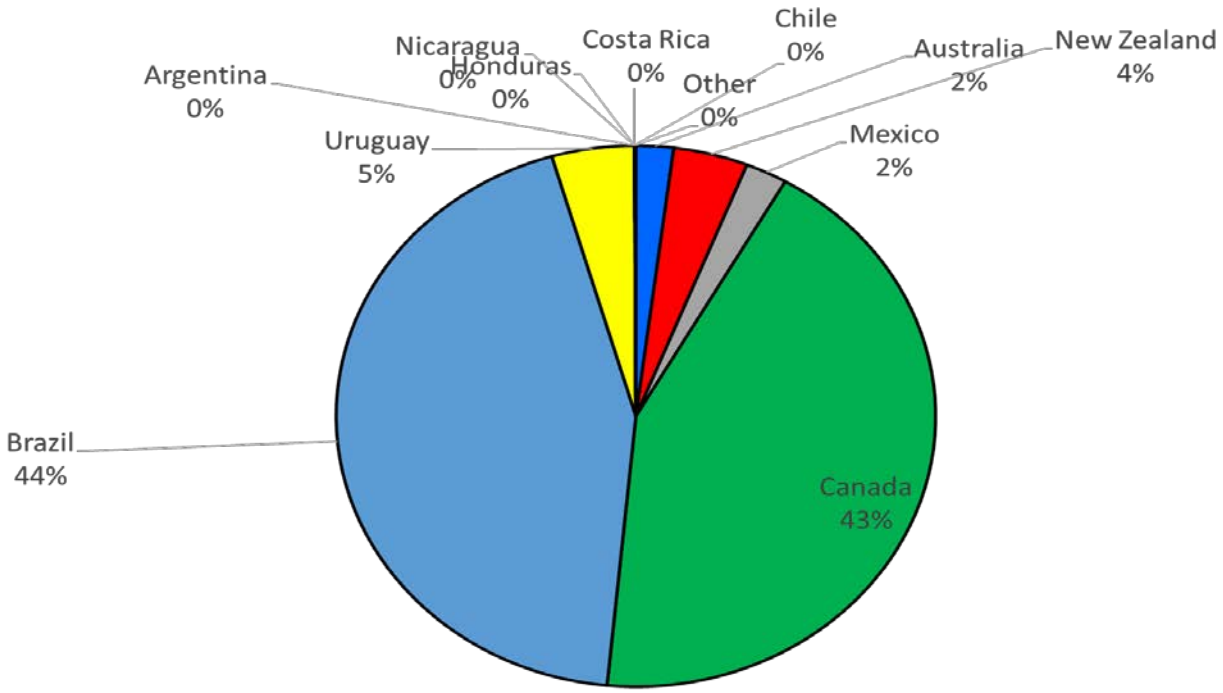


Figure 13. U.S. Beef Imports, Beef Cuts



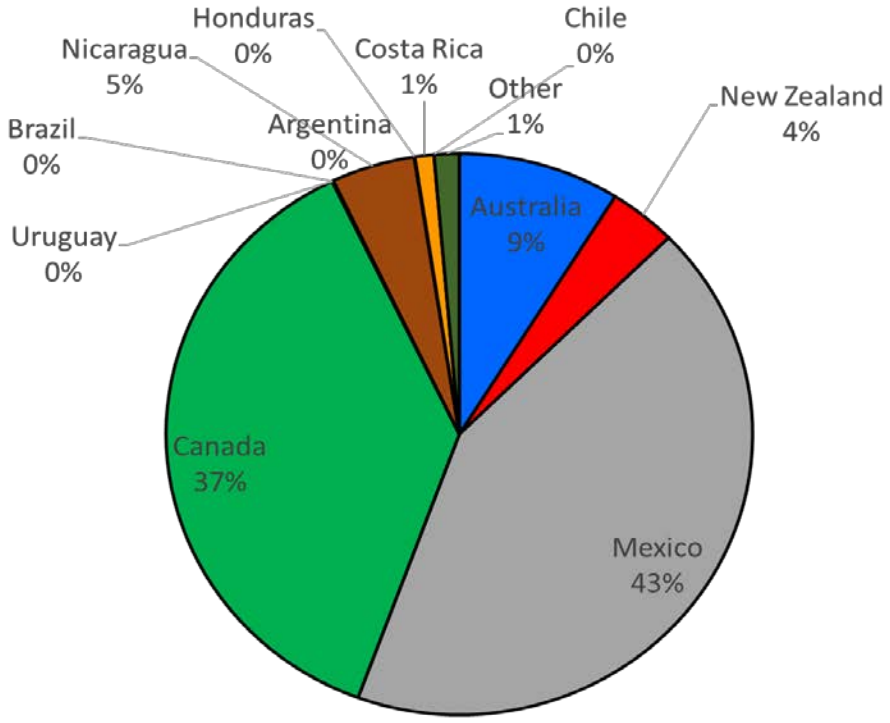
Beef Cuts Imports, 2016- 2020 Avg.

Figure 14. U.S. Beef Imports, Cooked



Cooked Beef Imports, 2016- 2020 Avg.

Figure 15. U.S. Beef Imports, Offals



Beef Offals Imports, 2016- 2020 Avg.

Beef Import Trends by Country of Origin

We now present several figures showing import volumes for 2013-2020 by country of origin. Care should be taken as vertical axis magnitudes change notably across figures, reflecting substantial differences in relative volumes by country.

Historically, Australia (along with Canada) has been the major source of U.S. beef imports (Figure 8.) Figure 16 shows that imports from Australia have been lower since the record 2015 levels. Most of the reduction has been in trim product which has declined from nearly 70 percent of total Australian product imported to just over 60 percent since 2016. Beef imports from Canada have increased in recent years, driven mostly by an increase in primal imports (Figure 17). Beef imports from New Zealand, which consist largely of trim, have been somewhat variable in recent years, with less cuts and some decrease in trim product (Figure 18). Mexico has been the fastest growing source of beef imports in recent years (Figure 8) with increased imports of cuts the major driver, but some increase in trim since 2017 (Figure 19). Brazil has been restricted to cooked product most of the time in recent years but the 2020 total imports from Brazil jumped significantly and included some fresh product, mostly trim, as a result of changes in sanitary regulations for Brazil (Figure 20). Beef imports from Nicaragua have increased steadily from 2016-2020 (Figure 21). Most of the increase is for trim imports, making Nicaragua the fifth largest source of beef imports in the 2016-2020 period. Uruguay has been a relatively steady, though minor source of beef imports in recent years (Figure 22). Costa Rica has been a very small source of mostly trim imports in recent years (Figure 23). Argentina has been largely absent as a source of beef imports in recent years until 2020 (Figure 24). It is unclear whether Argentina will be a significant source beef imports going forward due to uncertainty about government policies regarding beef exports in the country. Chile has been a

variable source of some beef imports at times in recent years (Figure 25). Honduras is also a minor source of beef imports, mostly trim (Figure 26).

Figure 16. U.S. Beef Imports, Australia

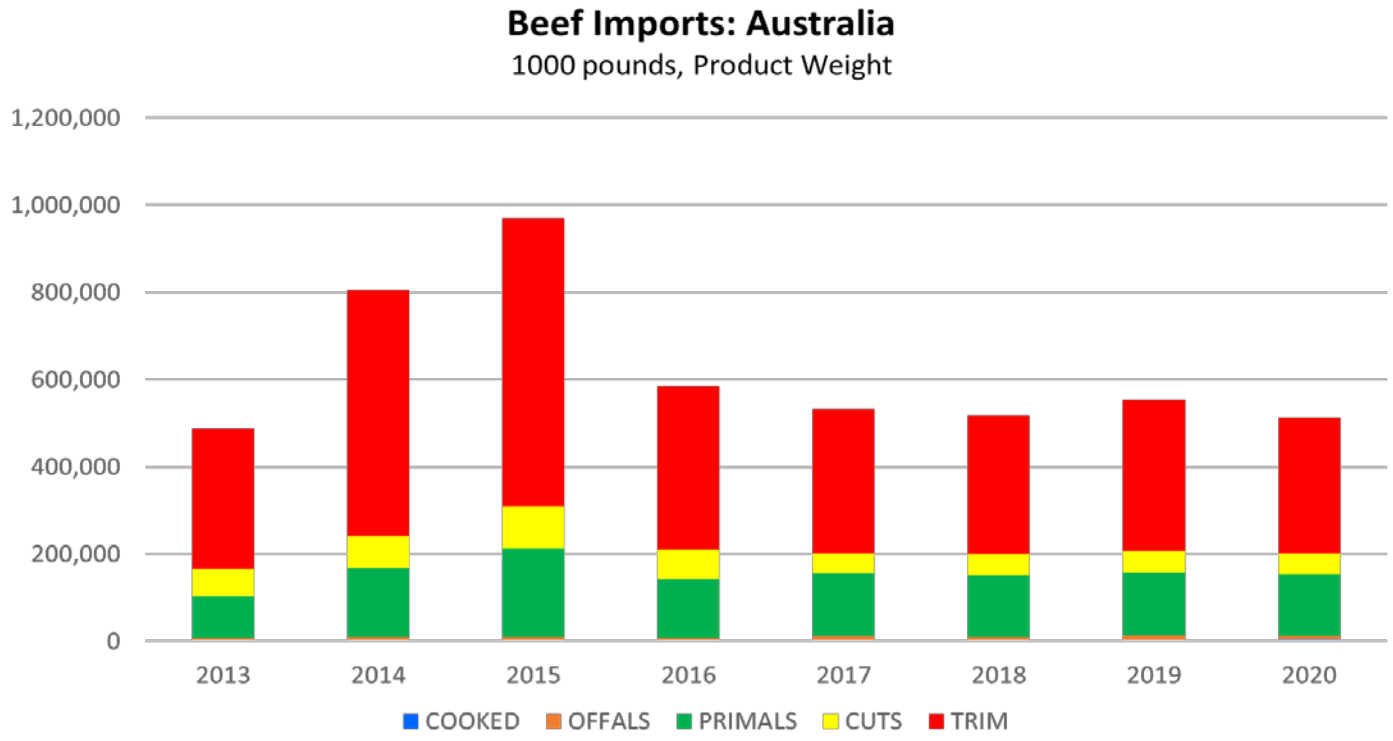


Figure 17. U.S. Beef Imports, Canada

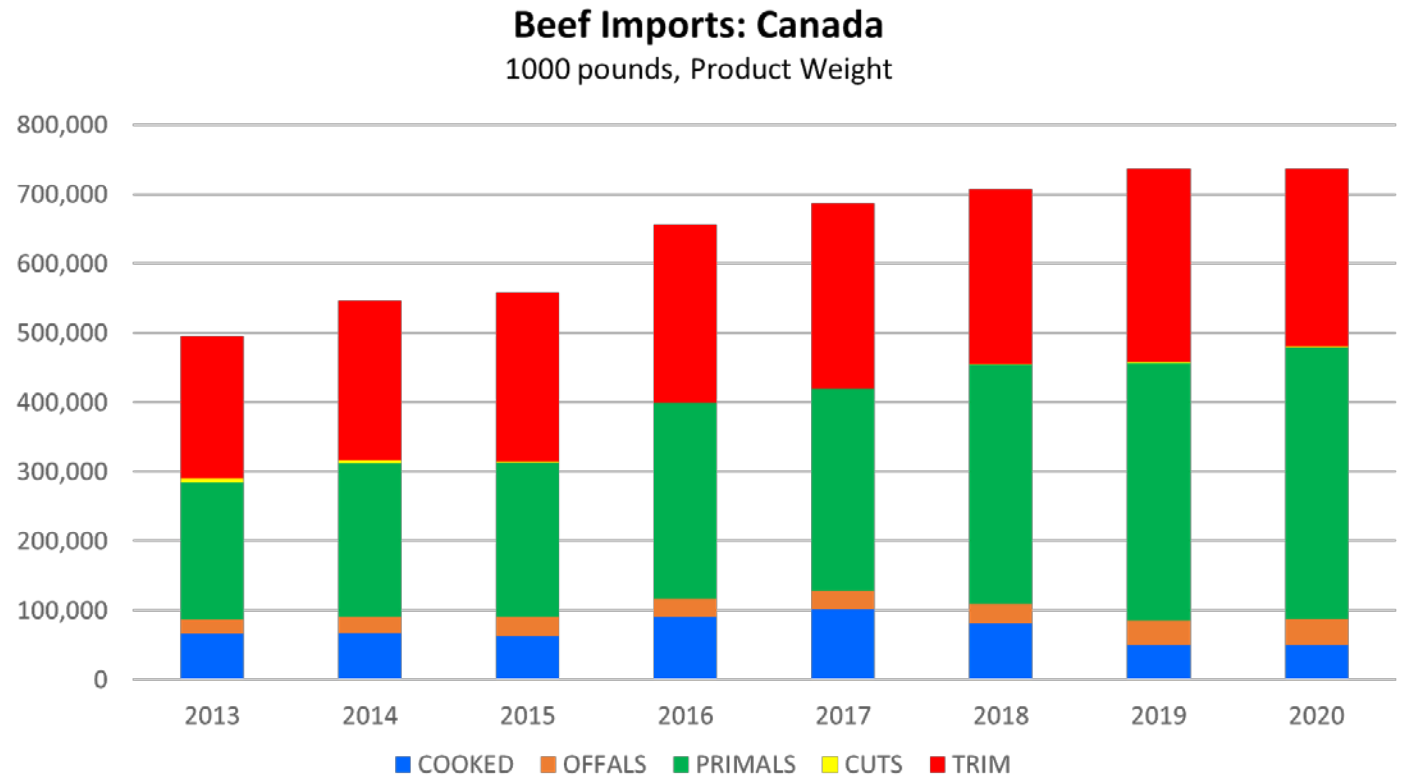


Figure 18. U.S. Beef Imports, New Zealand

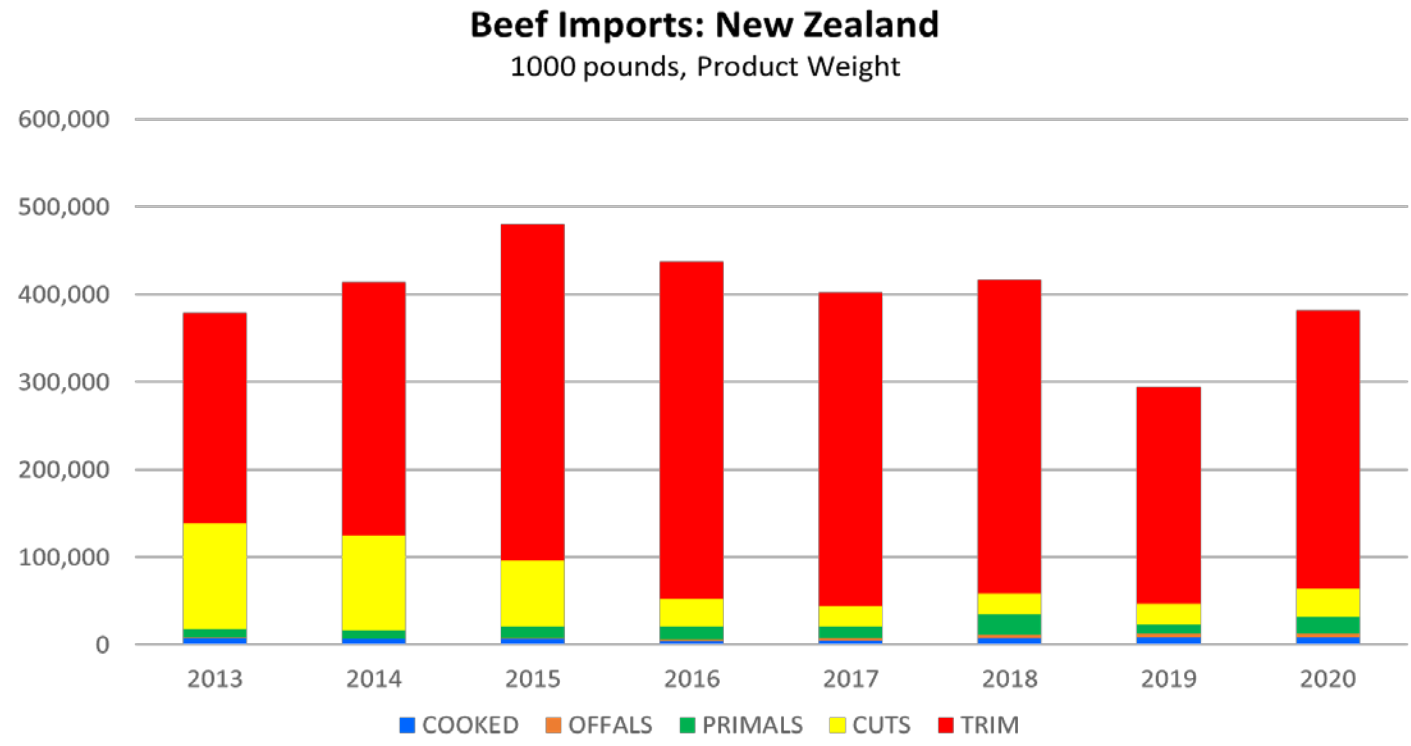


Figure 19. U.S. Beef Imports, Mexico

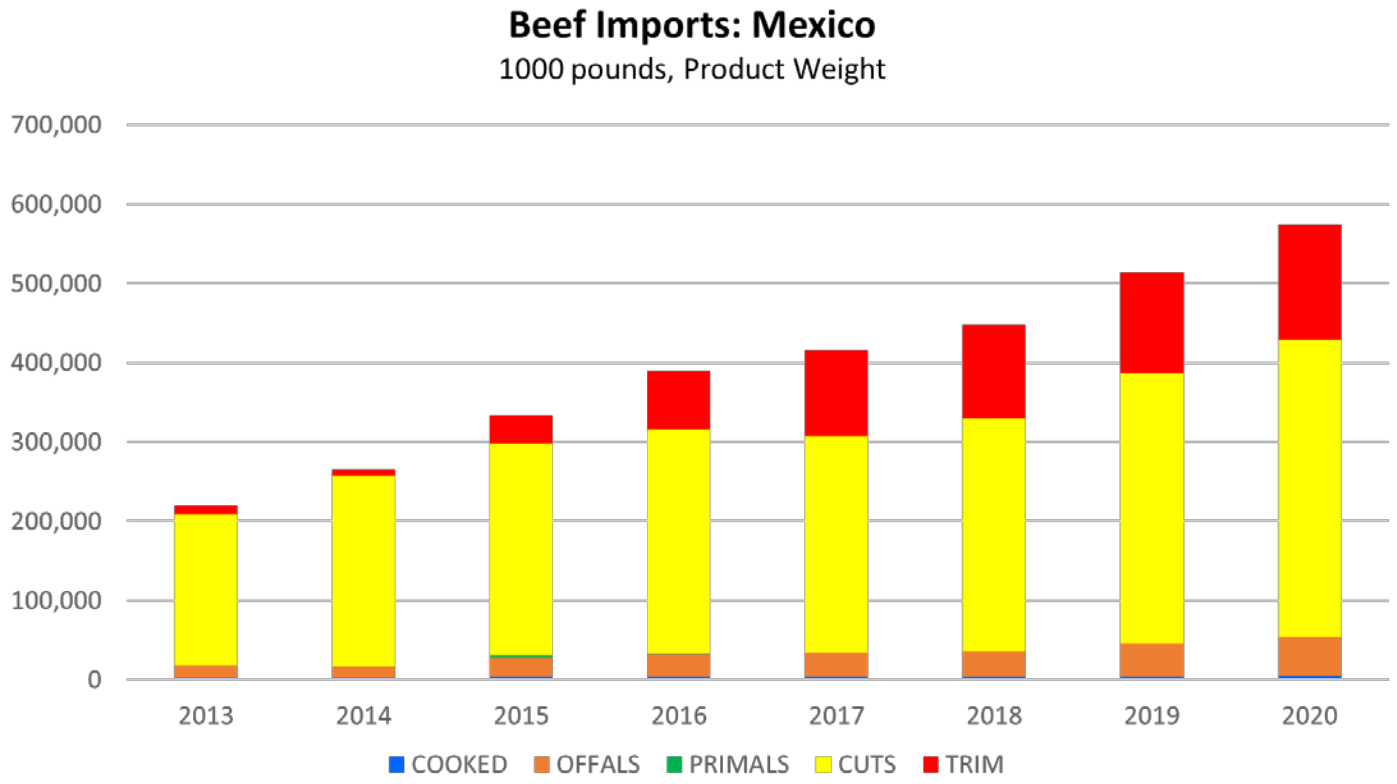


Figure 20. U.S. Beef Imports, Brazil

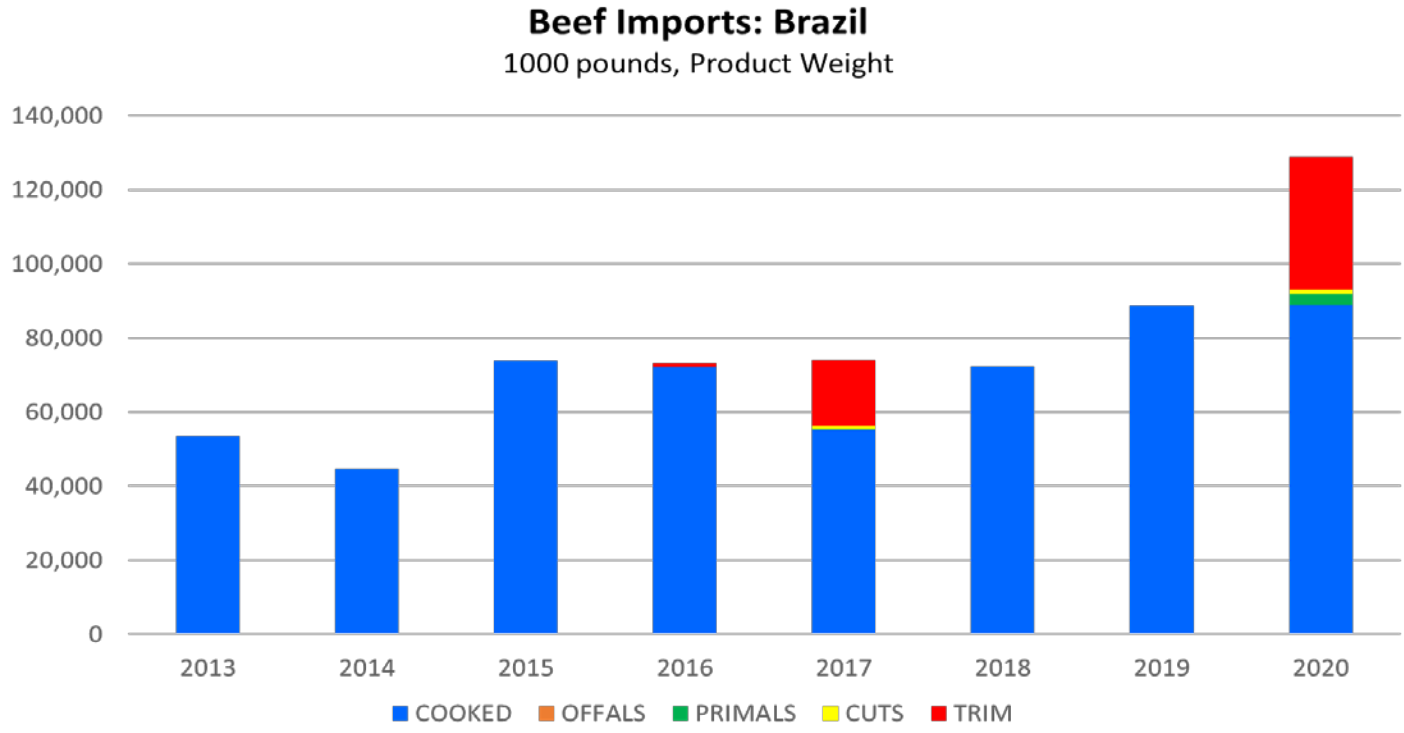


Figure 21. U.S. Beef Imports, Nicaragua

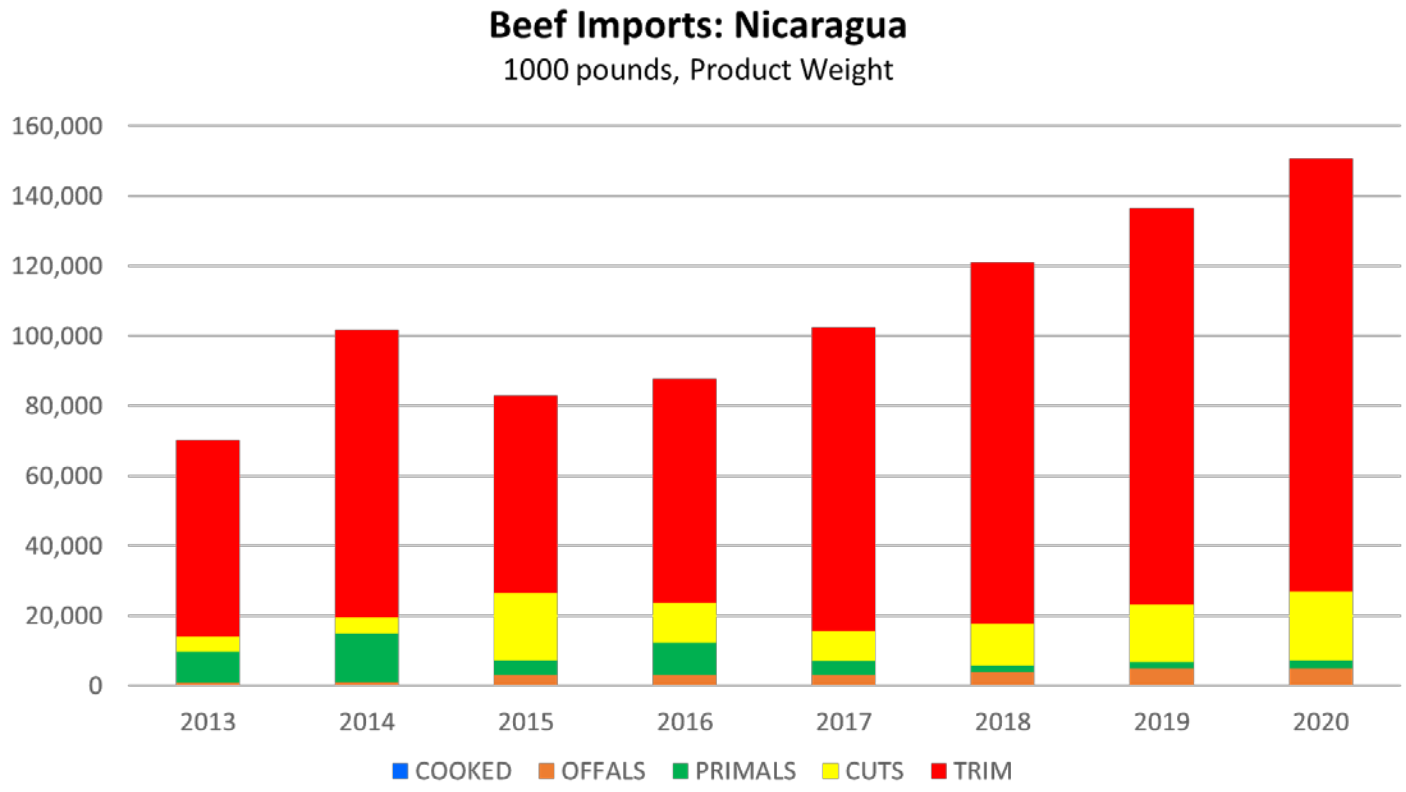


Figure 22. U.S. Beef Imports, Uruguay

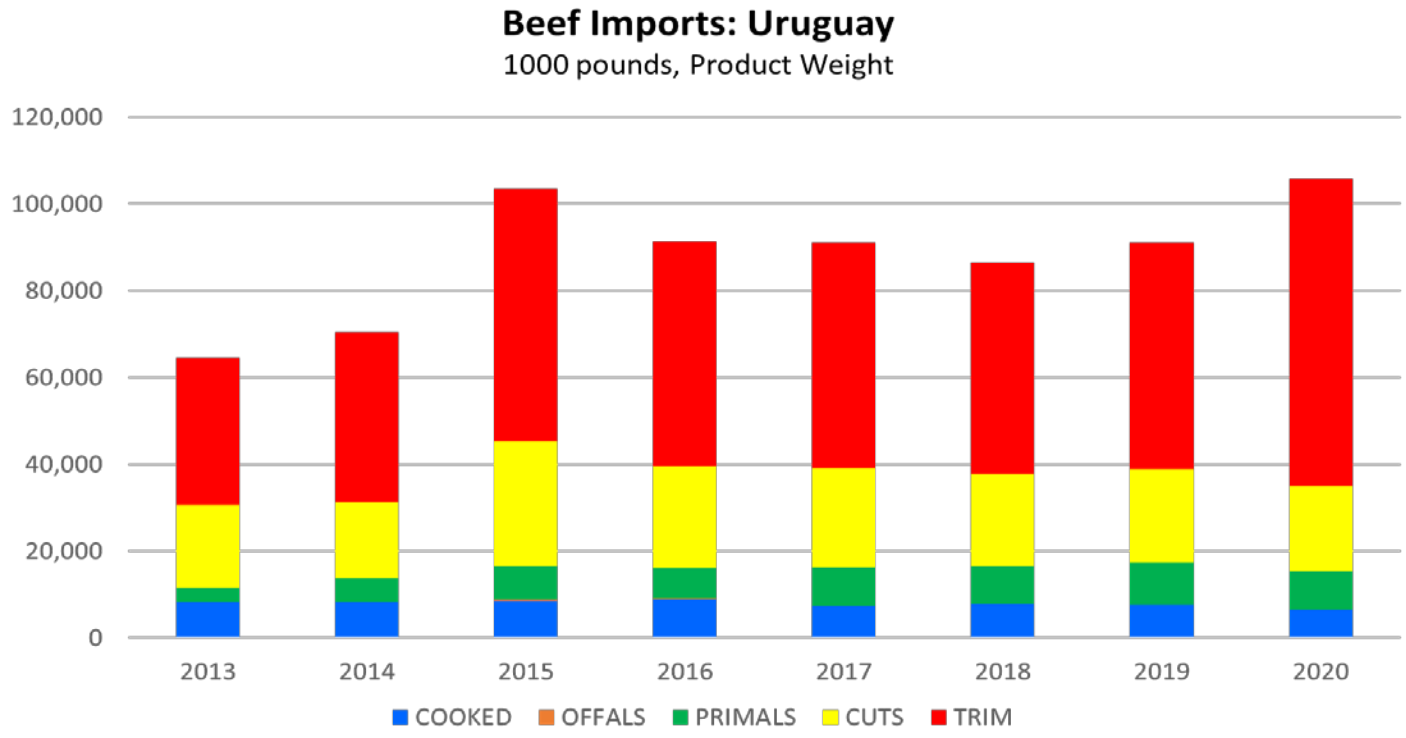


Figure 23. U.S. Beef Imports, Costa Rica

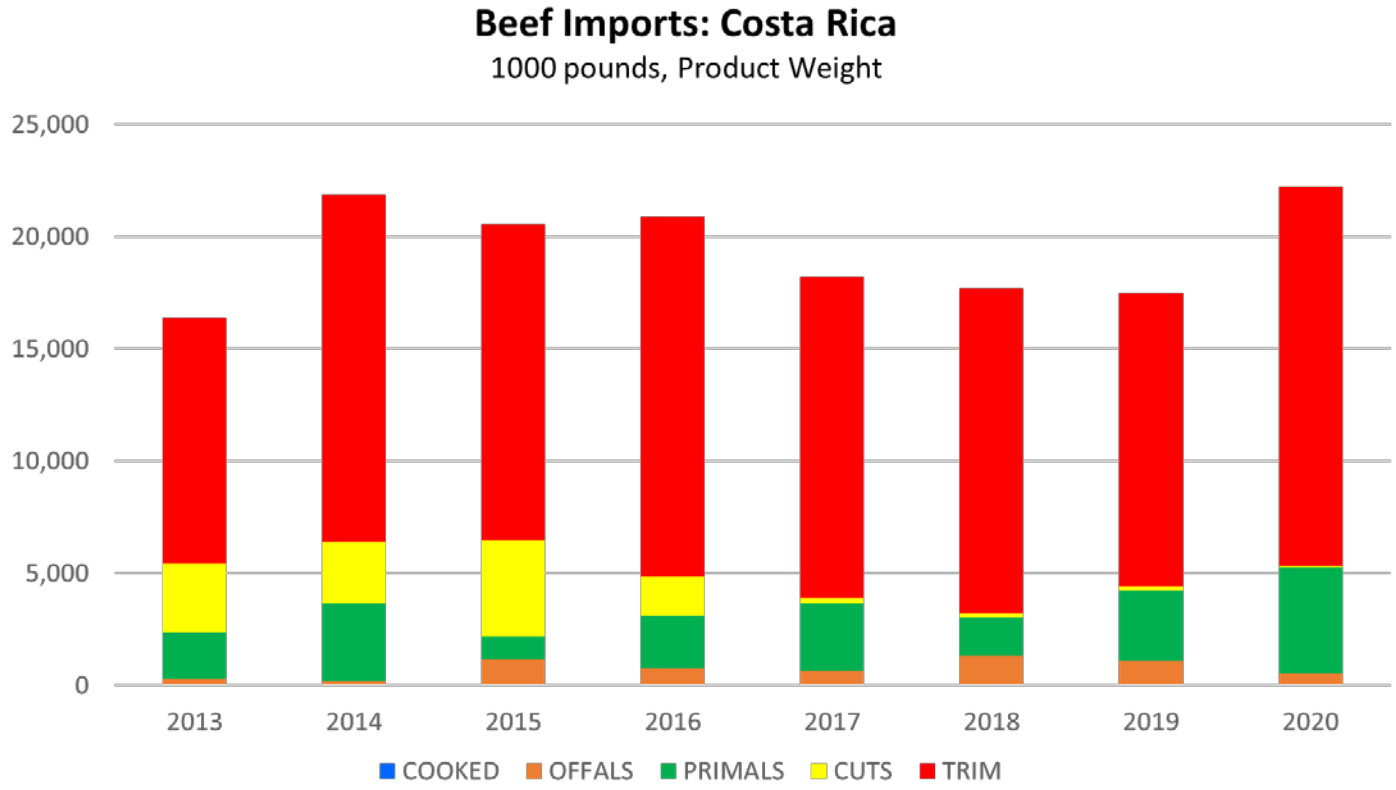


Figure 24. U.S. Beef Imports, Argentina

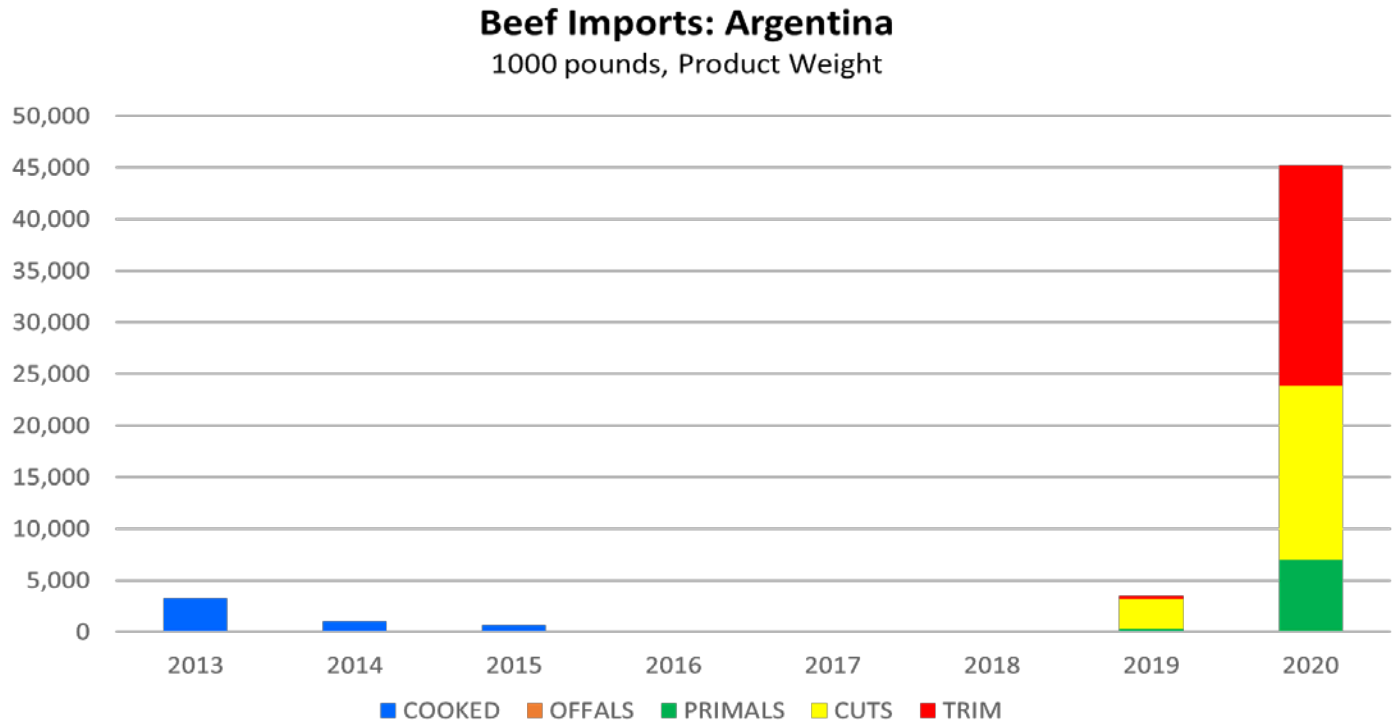


Figure 25. U.S. Beef Imports, Chile

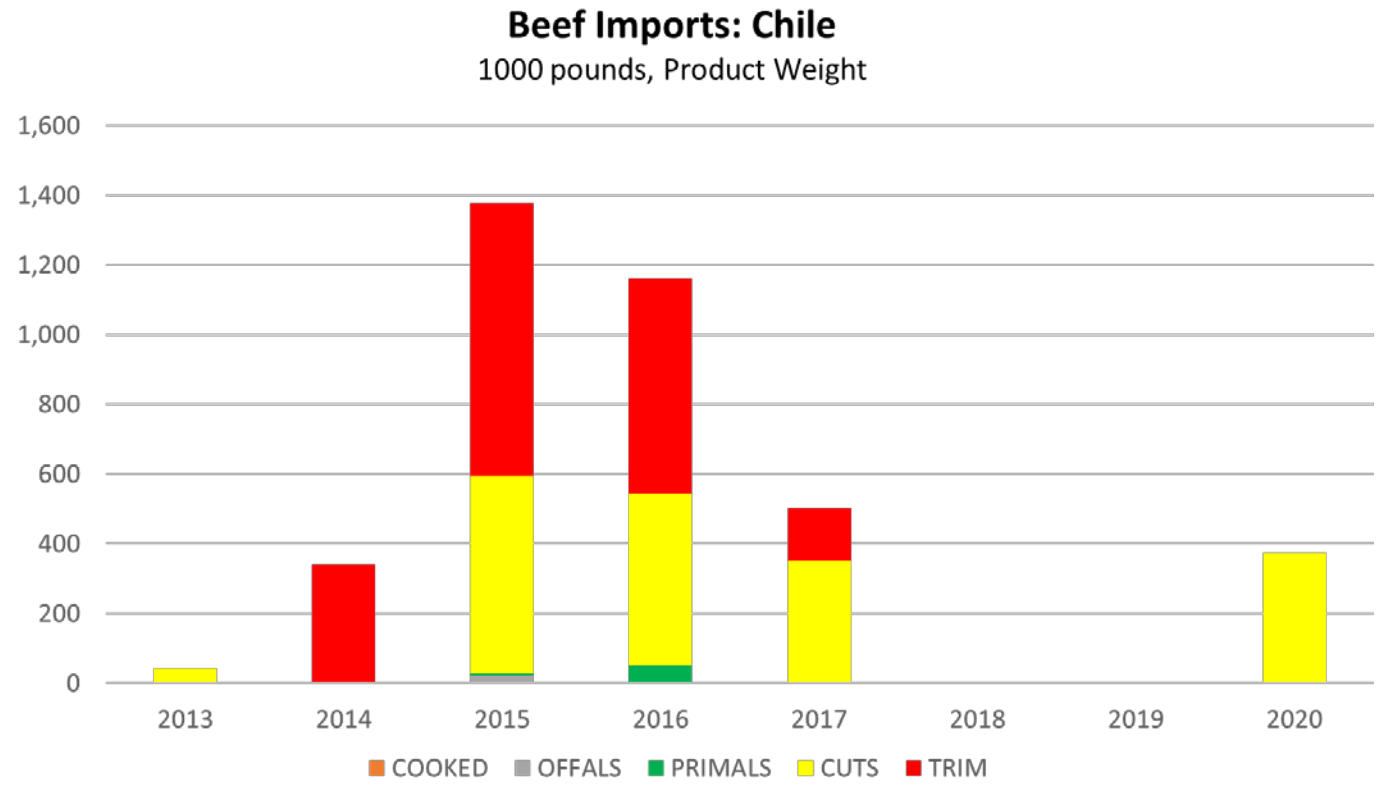
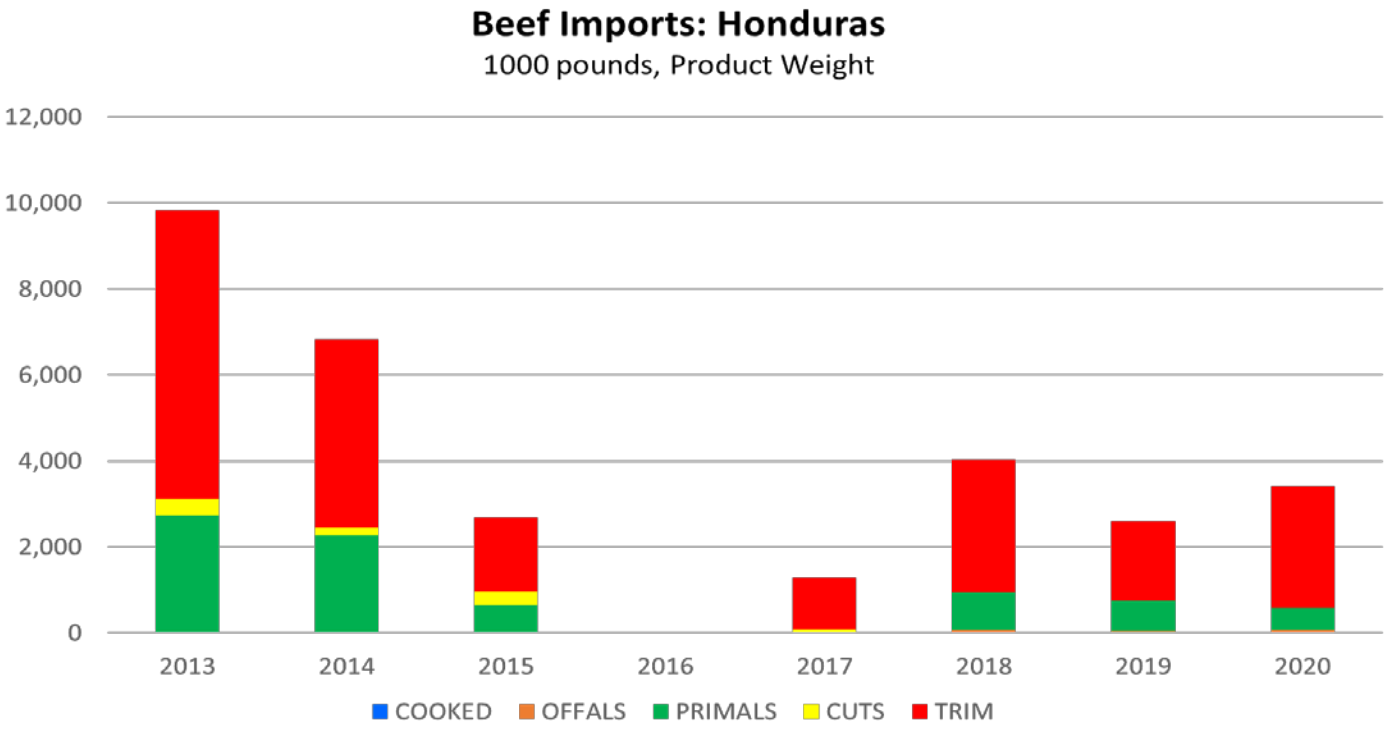


Figure 26. U.S. Beef Imports, Honduras

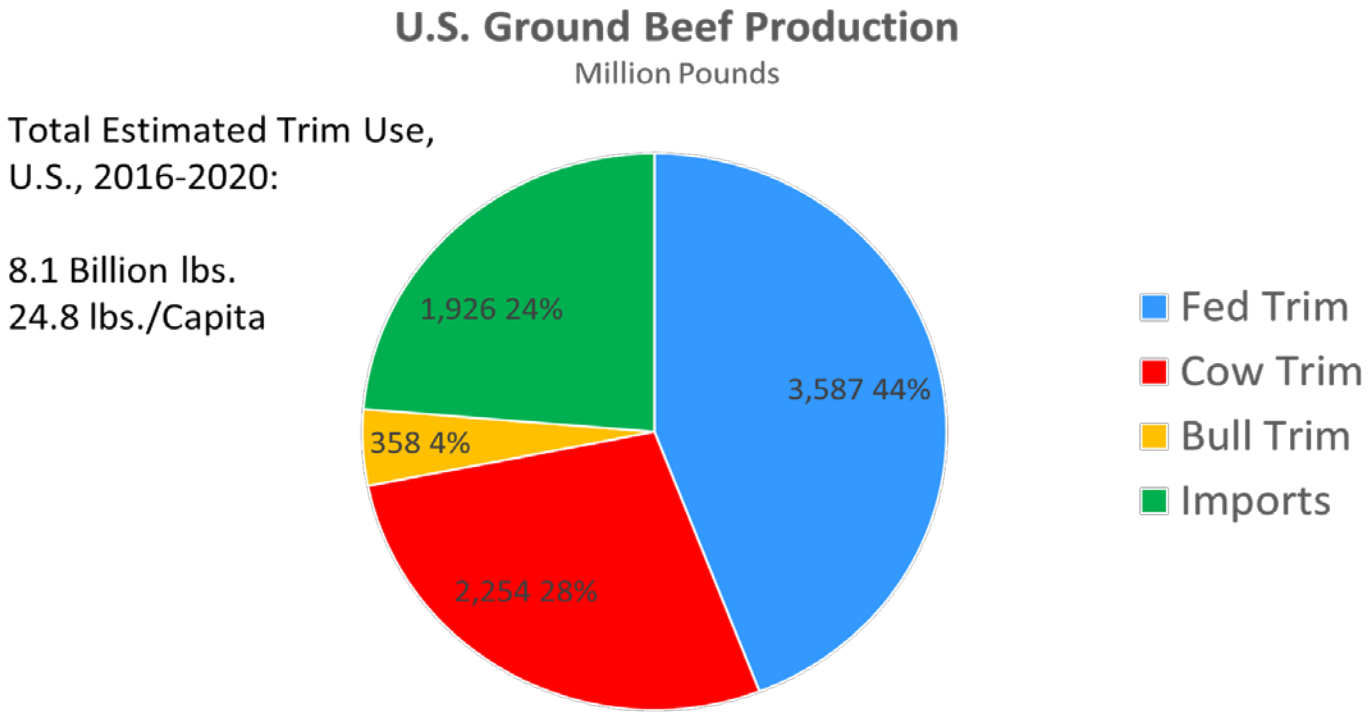


Beef Imports Summary

After analyzing the sources and composition of beef imports, what do we know about the role of beef imports in the U.S. beef industry? Clearly, the main driver of beef imports is the ground beef market resulting from the tremendous hamburger demand in the U.S. Figure 27 shows estimated average ground beef production in the 2016-2020 period and the profile of sources for total ground beef production. On average, ground beef represents approximately 31 percent of total beef production over this five-year period. Of the 8.1 billion pounds of ground beef, roughly 24 percent is imported beef.

The quantity of imported beef used for ground beef is nearly equal to the amount of cow beef used (1.93 billion pounds versus 2.25 billion pounds). Without the imported beef, there simply would not be enough lean beef to utilize all the fed trimmings produced in the U.S. for ground beef. This would lead to one of several outcomes. One possibility is to simply reduce the amount of ground beef produced, with excess fed trimmings rendered in the tallow market at much lower values. This would result in sharply higher ground beef prices and a significant reduction in ground beef volumes. A second possibility is to simply grind higher percentages of fed carcasses for lean to balance with fed trimmings. While enough Round products might be available to meet the ground beef lean requirements, it would cause enormous upheaval in other beef markets that currently utilize those products. Round and other beef cuts are not ground today because they have higher value in other uses. Using these products for grinding would lower the overall value to the industry. Finally, it would be possible for the industry to raise some proportion of steers and heifers as nonfed beef (think Australian range beef) to produce more lean meat comparable to cow and bull meat. These animals also have more value in the current system to be produced as feedlot finished animals. In total, beef imports allow the U.S. beef industry to expand total beef production and add value by utilizing fed trim most efficiently.

Figure 27. U.S. Ground Beef Production



At a much smaller level compared to the processing beef market, imports of primals/subprimals and beef cuts are utilized in other markets. Much of this is related to beef imports from Mexico and Canada and are the result of the proximity of these trading partners and the corresponding transportation economics. In particular, the long border between the U.S. and Canada and the general similarity of the industries in both countries means that many companies in both countries would consider product movements across the border as a routine matter. In such cases, north-south product flows are much more economical that east-west flows in both countries. This results in some bilateral movement of similar products that occurs simply because of the geography and shipping realities. Canada is the source of 65 percent of primal/subprimal imports and it is likely that a higher percent of these imports may be used for cuts rather than processing. Primal imports from other sources, such as Australia are more likely to also be used in processing markets. Mexico is the source of over 70 percent of beef cut

imports. These products are mostly marketed as cuts in retail grocery, often targeting Hispanic markets.

Imports of beef into the U.S. are an important economic component of the beef industry and serve various economic roles including supplemental sources of trim for ground beef production, economical alternatives for domestic products or specific products not available in the U.S. Beef imports are simply a part of vastly complex set of markets that make up the beef industry.

IV. Additional Beef Trade Insights – Volume, Value, and $/lb Patterns

This section primarily uses historical data available from USDA Foreign Agricultural Service (FAS) to document additional trends in U.S beef exports and imports. First volume trends are presented followed by monetary value trends. In addition to annual aggregate summaries, a parallel breakdown of trading partners as well as dynamics in market concentration are provided.[2] Finally data from the United States Meat Export Federation (USMEF) is incorporated to demonstrate the growing economic role of beef and variety meat exports. Combined this provides a detailed summary of both the current and past U.S. beef export and import situation. This intentionally builds upon insights in the previous chapter supplying export information that parallels similar import information.

Volume Trends

Exports

It is useful to summarize U.S. beef trade statistics over multiple decades. To do so, here we further utilize FAS historic trade data. Figure 28 depicts annual U.S. beef exports from 1967 to 2020, broken down by the three product types used by FAS: unprepared (fresh, chilled, and frozen), prepared, and variety beef. Notice first the substantial upward trend in exports from the mid-1980s through 2003. Over the course of 18 years, total export volume rose from 660 million pounds (1985) to 2,809 million pounds (2003), an increase of 326 percent. The majority of this growth is contributable to Japanese demand, which we discuss further in the following section.

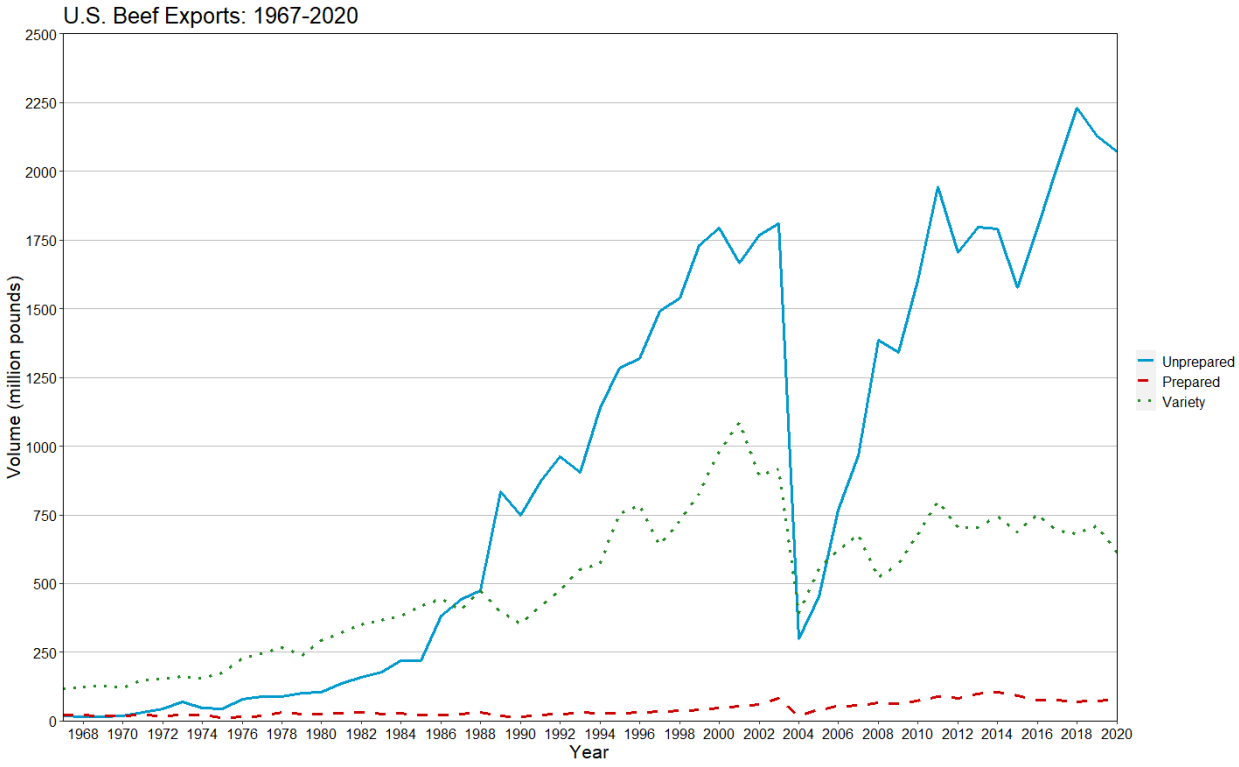
December 2003 witnessed the discovery of a BSE-infected dairy cow in the state of Washington, sparking uncertainty in U.S. cattle markets and an abrupt restriction on imports of U.S. beef by most trade partners, particularly outside of North America. Beef exports decreased from 2003 to 2004 by 75 percent, with total volume dropping to 710 million pounds—back to

[2] We thank Justin Bina for his extensive assistance with this chapter.

roughly 1985 levels. It took seven years for U.S. beef exports to regain the volume experienced throughout the 1990s, with 2011 export volume reaching 2,833 million pounds. Growing export demand since the BSE event has come primarily from unprepared beef, with variety beef volume still having not recovered to levels experienced before the incident.

U.S. beef export volume over the last 10 years (2011-2020) has averaged 1,905 million pounds, 84 million pounds, and 710 million pounds for unprepared, prepared, and variety beef, respectively. 2018 and 2019 witnessed historically high U.S. beef export demand, approaching 3,000 million pounds. These elevated levels tailed off to an extent in 2020, with the U.S. exporting 2,070 million pounds of unprepared beef (114 percent of 2003 levels), 81 million pounds of prepared beef (97 percent of 2003 levels), and 612 million pounds of variety beef (67 percent of 2003 levels), for a sum total of 2,762 million pounds. The direct (e.g., logistical) and indirect (e.g., global GDP uncertainty) impacts of the COVID-19 pandemic underlie this decline in 2020.

Figure 28. U.S. Beef Exports, 1967-2020



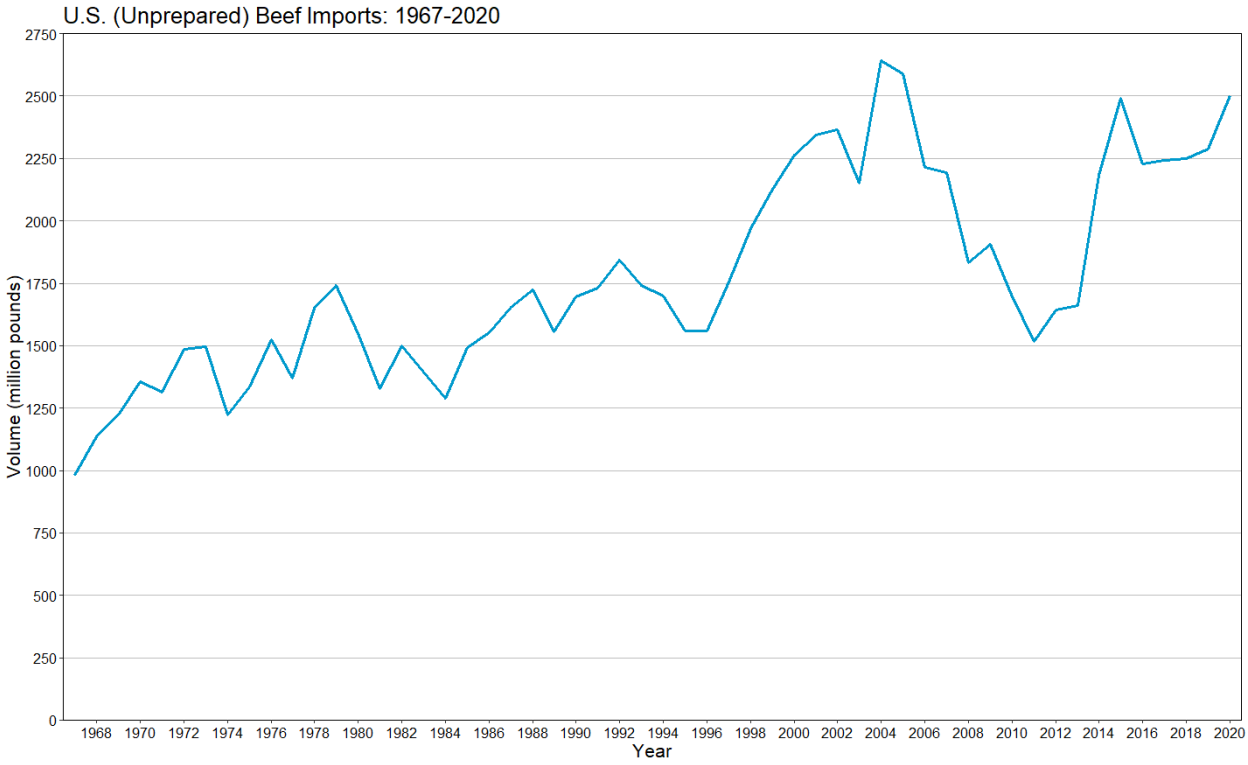
Imports

The U.S. has likewise witnessed important changes in beef import volume over time, depicted in Figure 29. Note the USDA FAS reports only unprepared (fresh and chilled) beef imports. Beef import volume was relatively steady from the late-1960s to mid-1990s, averaging around 1,500 million pounds per year. Beginning in 1996, beef imports rose from 1,560 million pounds to 2,640 million pounds in 2004, an increase of 69 percent. Historically high U.S. beef imports in 2004 and 2005 were the result of domestic production issues stemming from the late-2003 BSE incident.

As the U.S. cattle market moved on from the BSE event and as (drought-induced) herd liquidation persisted through the late-2000s, beef import volume declined, bottoming out in 2011 to levels consistent with those experienced in the mid-1990s. Substantial increases in beef imports were then realized from 2012 onward, corresponding to 50-year-lows in cattle

inventories and the associated pulldown in domestic beef production. From their low in 2011 of 1,518 million pounds, U.S. beef imports rose to 2,500 million pounds in 2020.

Figure 29. U.S. (Unprepared) Beef Imports, 1967-2020



Sources of Trade

With knowledge of aggregate historic U.S. beef trade volume across all trading partners, we now analyze export destinations and sources of imports. An understanding of trade partners, and U.S. reliance on particular countries, is important as it allows for a better assessment of the position held by the U.S. in the global market for beef and beef products, as well as aids policymakers in trade decisions that can have profound impacts on the industry. A summary of major trade partners by decade is available in the Appendix.

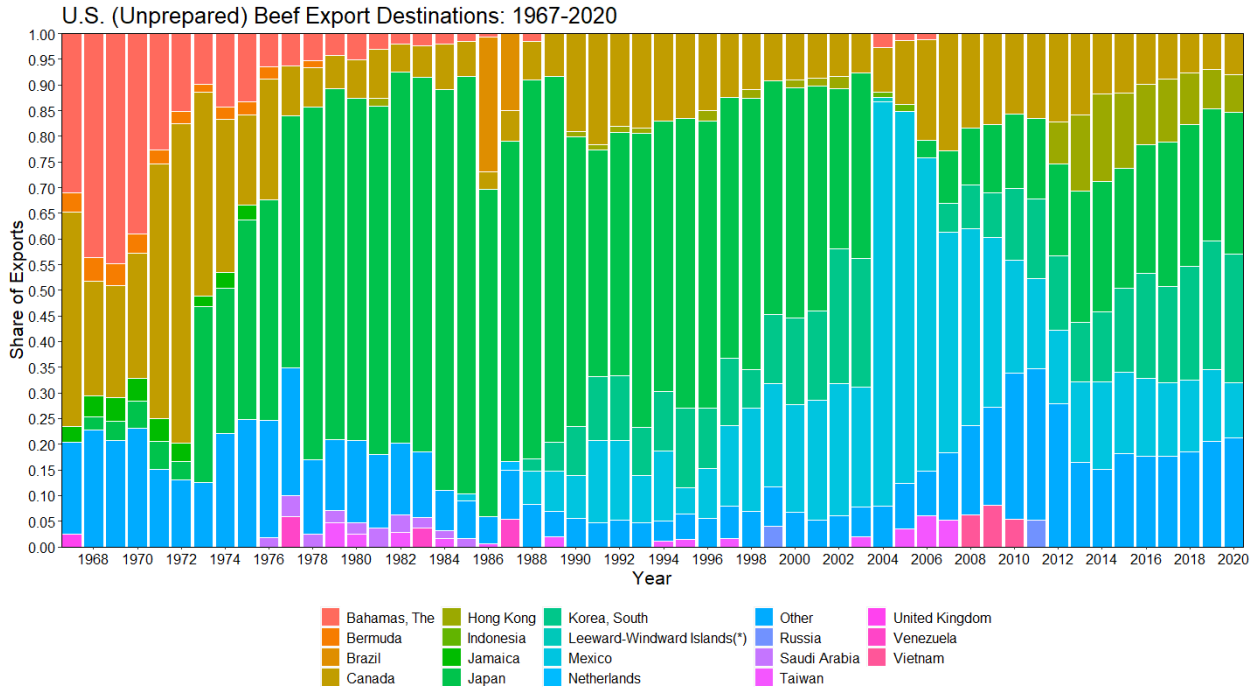
Export Concentration

Figure 30 depicts the top five U.S. beef export destinations over time (unprepared beef only).[3] Country-level exports are displayed as a share of total export volume to highlight U.S. reliance on any given country. Of note is a substantial reliance on Japanese demand for U.S. beef from the mid-1970s until the BSE incident in 2003. The U.S. routinely directed half or more of its beef exports to Japan in this time frame, peaking in 1985 at 81 percent. In the years immediately following the BSE event, Mexico was, by large, the primary destination for U.S. beef exports. In 2004, 79 percent of beef exports went to Mexico, with this share remaining above one third through 2009.

Historically, we see the U.S. has relied heavily on one or two beef export destinations at any given time; Canada and the Bahamas in the late-1960s and early-1970s, Japan from the mid-1970s through 2003, and Mexico from 2004 through the end of the decade. However, the 2010s were characterized by comparatively less reliance on any given country. In 2020, U.S. beef exports were split between Japan (28 percent), South Korea (25 percent), Mexico (11 percent), Canada (8 percent), Hong Kong (7 percent), and all other importers (21 percent).

[3] Figures 30 and 35 depict each years' top five export destinations and import sources, respectively, with a sixth category denoting the share of exports (imports) going to all other countries. Additional detail is tabulated in the Appendix.

Figure 30. U.S. (Unprepared) Beef Exports by Destination, 1967-2020



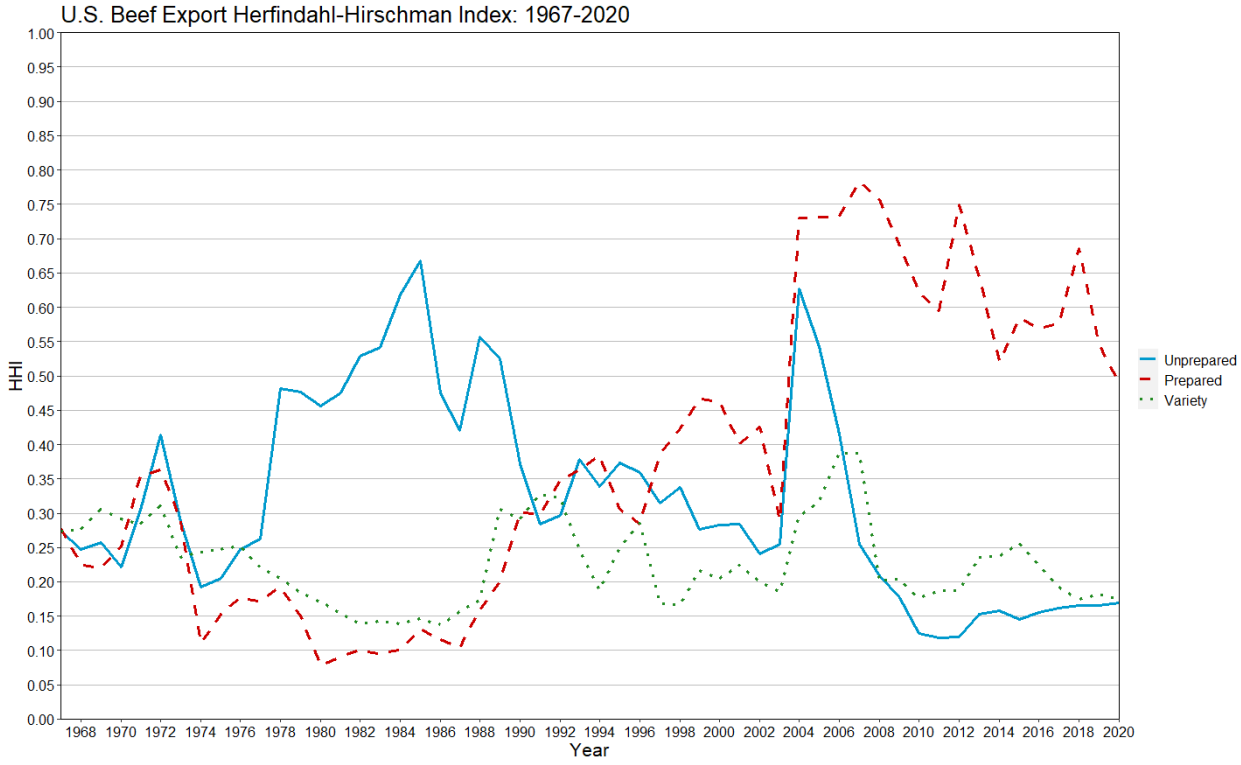
This shift in U.S. reliance on a few importing countries to relatively many countries can be measured by the Herfindahl-Hirschman Index (HHI) statistic; a commonly used metric of industry concentration.[4] The HHI, depicted in Figure 31, was computed by squaring the share of beef exports going to each country and then summing the squares. Values close to zero indicate less concentration in the U.S. beef export market, while values close to one reflect all U.S. beef exports going to a single country.

Reflecting substantial reliance on Japanese and Mexican markets for U.S. unprepared beef, the HHI was historically high through the 1980s and immediately following the 2003 BSE incident—approaching 0.65 on two separate occasions. The 2010s, as discussed previously, witnessed export volume more evenly spread across numerous countries and the HHI for

[4] See Tonsor (2020) for additional discussion on the HHI measure used here.

unprepared beef fell to around 0.15.[5] Implied in this observation is that the U.S. is less beholden to any single country in marketing unprepared beef and may have more capability to shift trade to new or existing trade partners without the same repercussions to the industry that may have occurred in earlier years. In the presence of volatile world trade conditions, this increased capacity to adapt provides an important safety net.

Figure 31. U.S. Beef Export HHI, 1967-2020



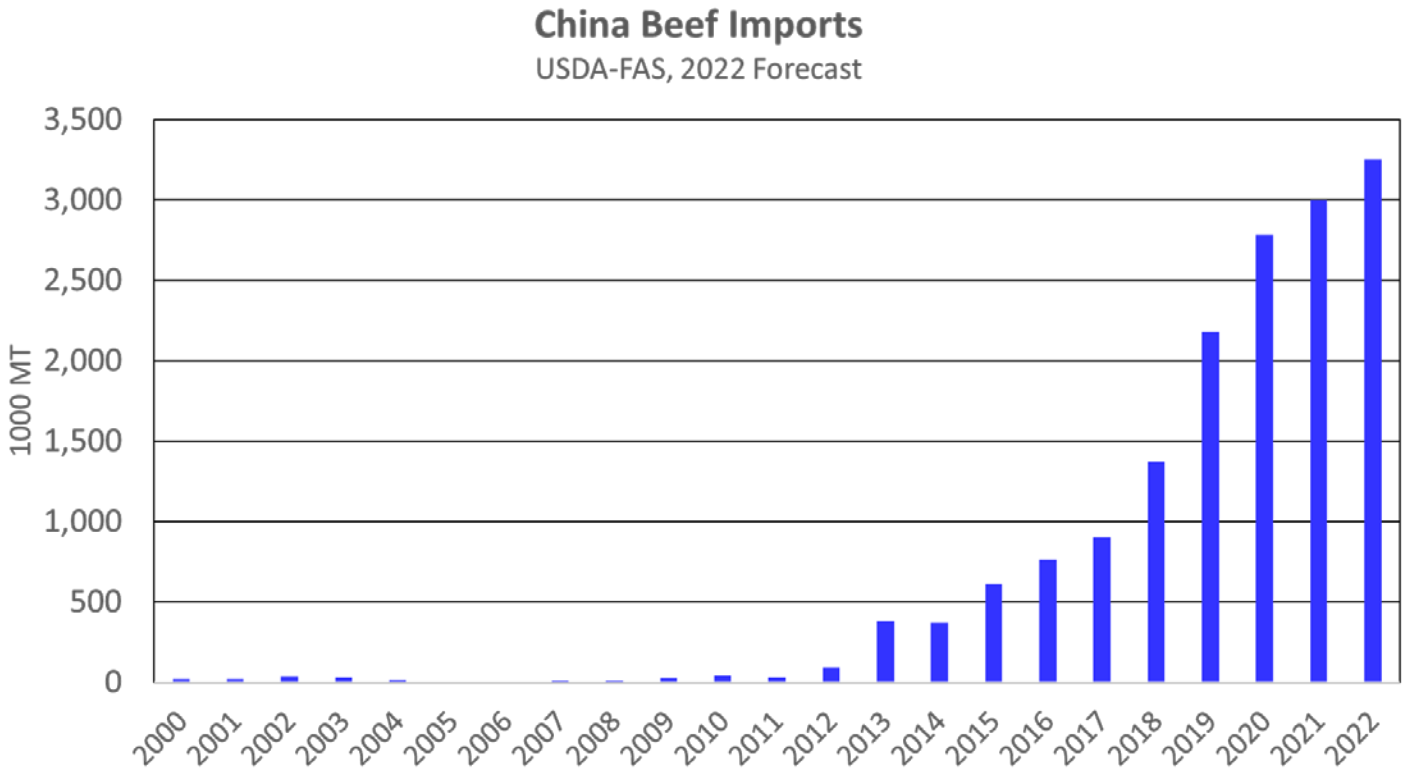
New Developments: Emergence of China in Global Beef Markets

China is a large country with a large population and although relatively small levels of beef were consumed per capita, total beef production and consumption was large in absolute amounts. However, historically, China did not participate in global beef markets as either an exporter or importer of beef. Beginning in 2013, beef consumption in China began to exceed

[5] Though prepared beef exports experienced opposite trends, prepared beef accounts for only a small portion of total export volume.

production and the country began importing significant quantities of beef from international markets. Figure 32 shows the dramatic increase on Chinese beef imports in recent years. The growing demand for beef in China was augmented by the protein shortages resulting from African Swine Fever (ASF) impacts on China's pork production. China is by far the largest beef importing country in the world.

Figure 32. China Beef Imports, 2000-2022 (forecast)



China did not begin to import U.S. beef in significant quantities until 2020 and more so in 2021. Figure 33 shows the total exports of beef into China and Hong Kong (HK) combined. Although the data for China and HK are available separately, it is really one market. While HK separately has been a major U.S. beef export destination for a decade, the growth in exports to China has replaced some exports to HK. This was expected as it was known that some portion of HK exports were, in fact, entering China prior to official U.S. access to China. Data for China

and HK are appropriately added together. Figure 34 confirms that the total of exports to combined China/HK has increased dramatically since 2019, especially in 2021, making China/HK the third largest beef export market. Through November 2021, China/HK represented a 19.3 percent share of U.S. beef exports and the third largest export market behind Japan (24.2 percent share) and South Korea (23.0 percent share). The January-November 2021 data suggest that the U.S. is on track to set a new record for beef exports, due in no small part to the growth exports to China/HK, which were up 110 percent year over year on a year-to-date basis.

Figure 33. U.S. Beef Exports to China/Hong Kong (Jan. 2016 – Nov. 2021)

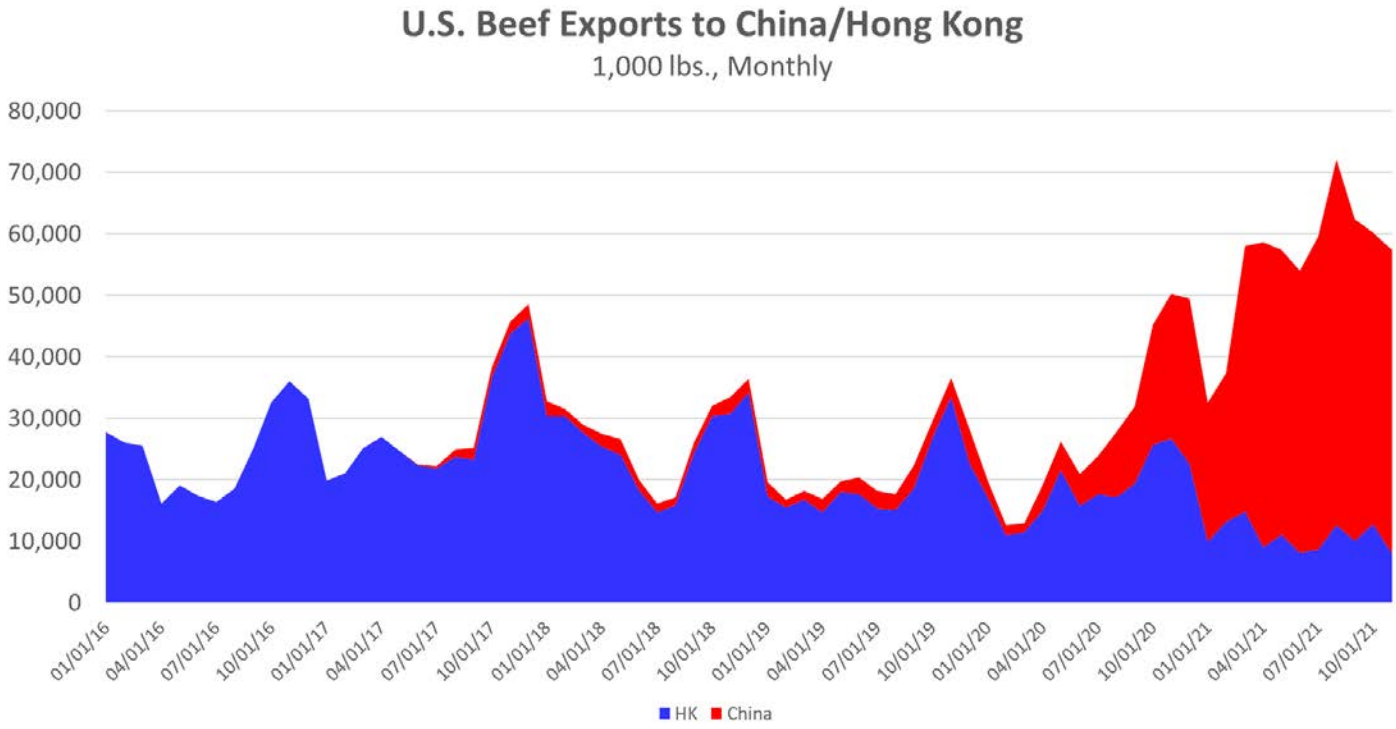
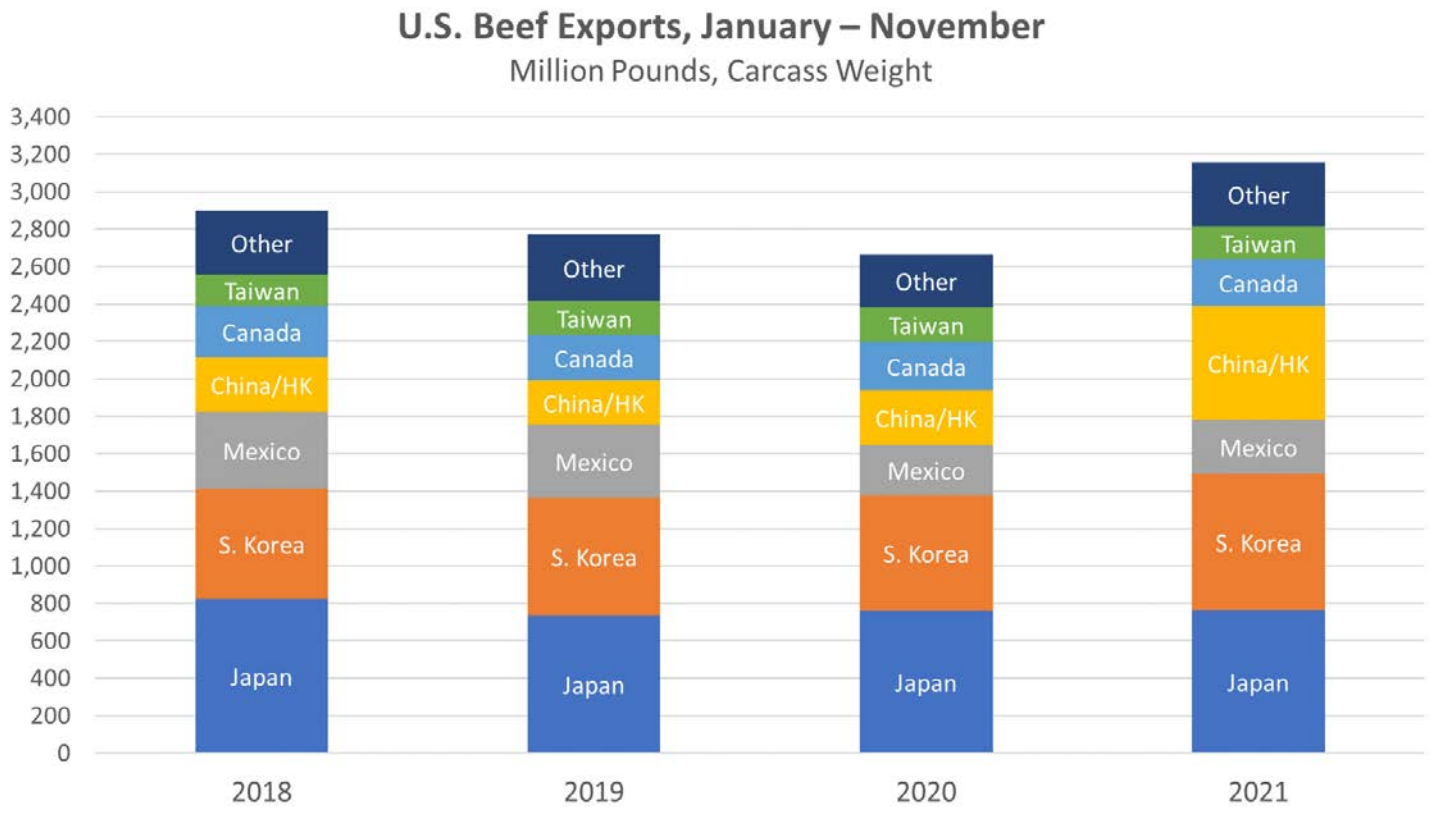


Figure 34. U.S. Beef Exports, Jan-Nov by Destination (2018-2021)



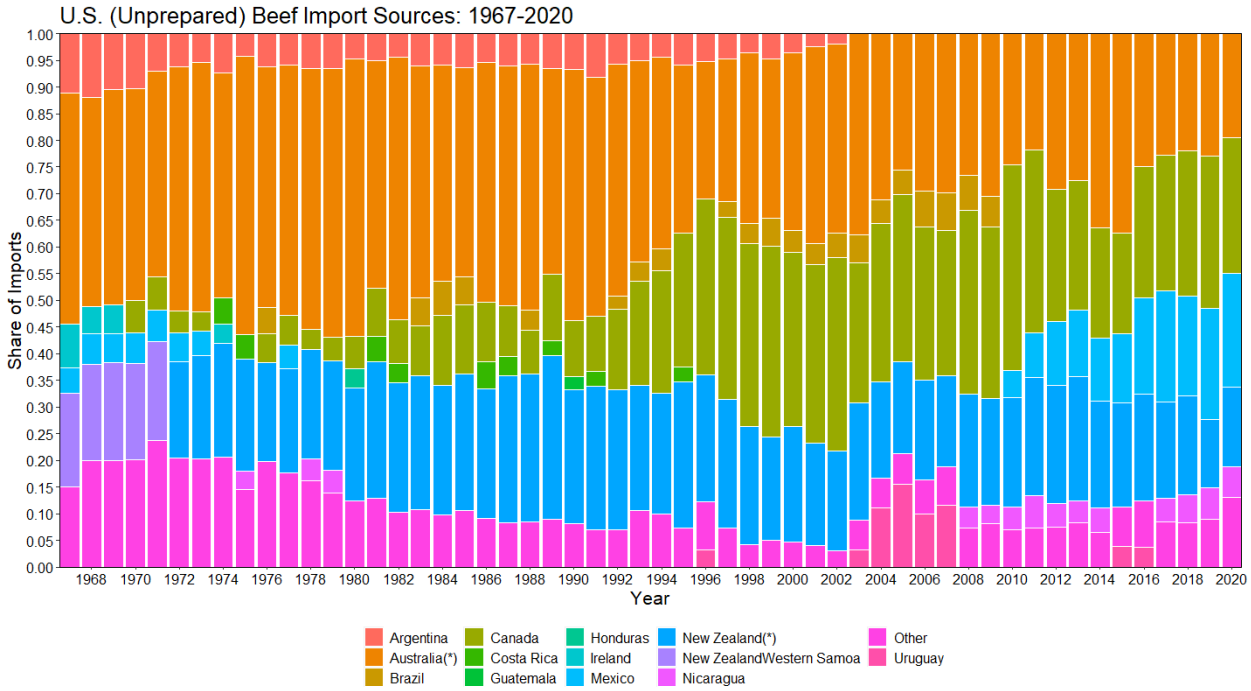
Import Concentration

Analogous assessments can be made for U.S. beef imports. Recall, the USDA FAS reports only imports of unprepared (fresh and chilled) beef. Figure 35 depicts the top five U.S. beef import sources over time (again displayed as a share of total import volume). Immediately, we notice the share of imports from any given country is more balanced and more consistent over time compared to beef exports.

Australia, historically, has been a major source of U.S. beef imports, accounting for between 40 and 50 percent of import volume from 1967 to 1992. Beginning around 1993, the share of imports coming from Australia decreased to 20-30 percent as Canada emerged as a major source of beef. Additionally, the 2010s witnessed increases in beef sourced from Mexico, making the country one of the U.S.' primary beef trade partners. In 2020, U.S. beef imports were

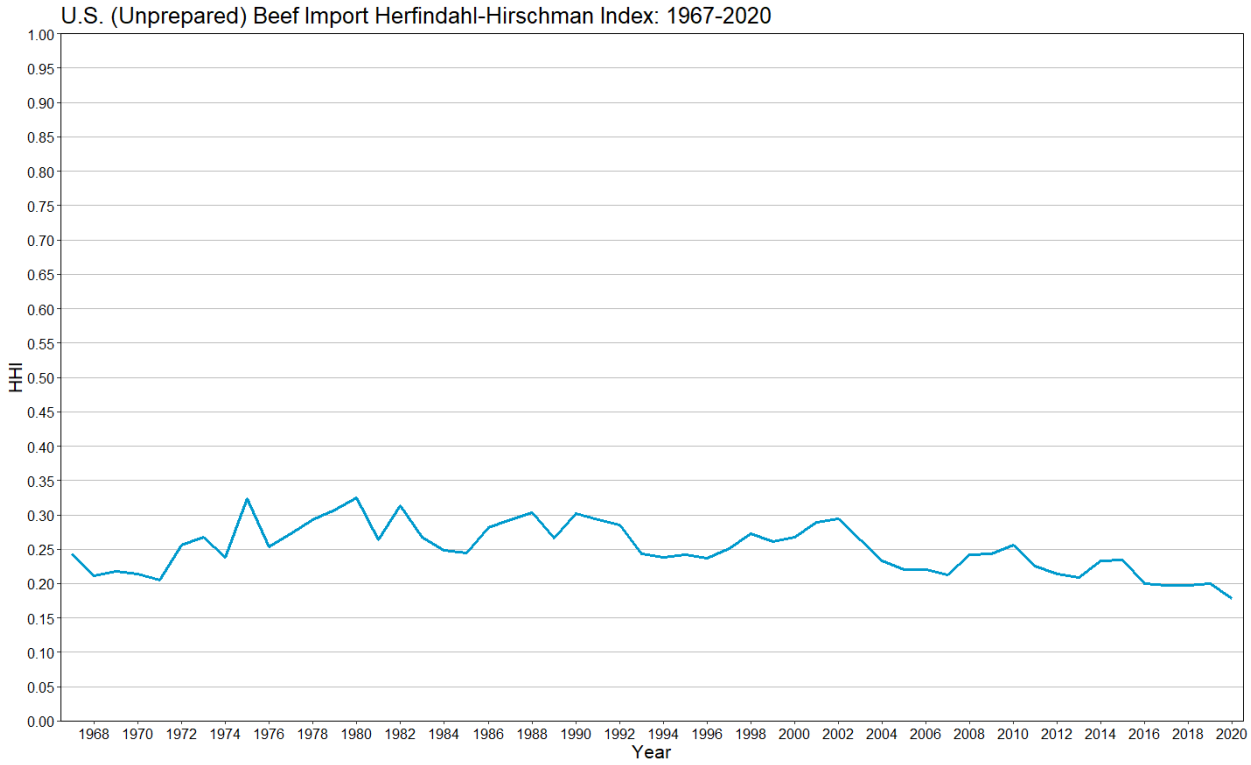
split between Canada (26 percent), Mexico (21 percent), Australia (19 percent), New Zealand (15 percent), Nicaragua (6 percent), and all other exporters (13 percent).

Figure 35. U.S. (Unprepared) Beef Imports by Source, 1967-2020



Again, the HHI can be calculated to measure concentration in U.S. beef import sources over time. This measure is depicted in Figure 36. As opposed to beef exports, imports have experienced a HHI that has fluctuated very little historically. We do notice slight declines from around 0.30 in the early-1980s to around 0.25 in the mid-1990s as Canada gained prominence in U.S. beef trade. Similarly, the HHI declined to around 0.20 in the late-2010s, corresponding with an increase in beef imported from Mexico.

Figure 36. U.S. (Unprepared) Beef Import HHI, 1967-2020



Value Trends

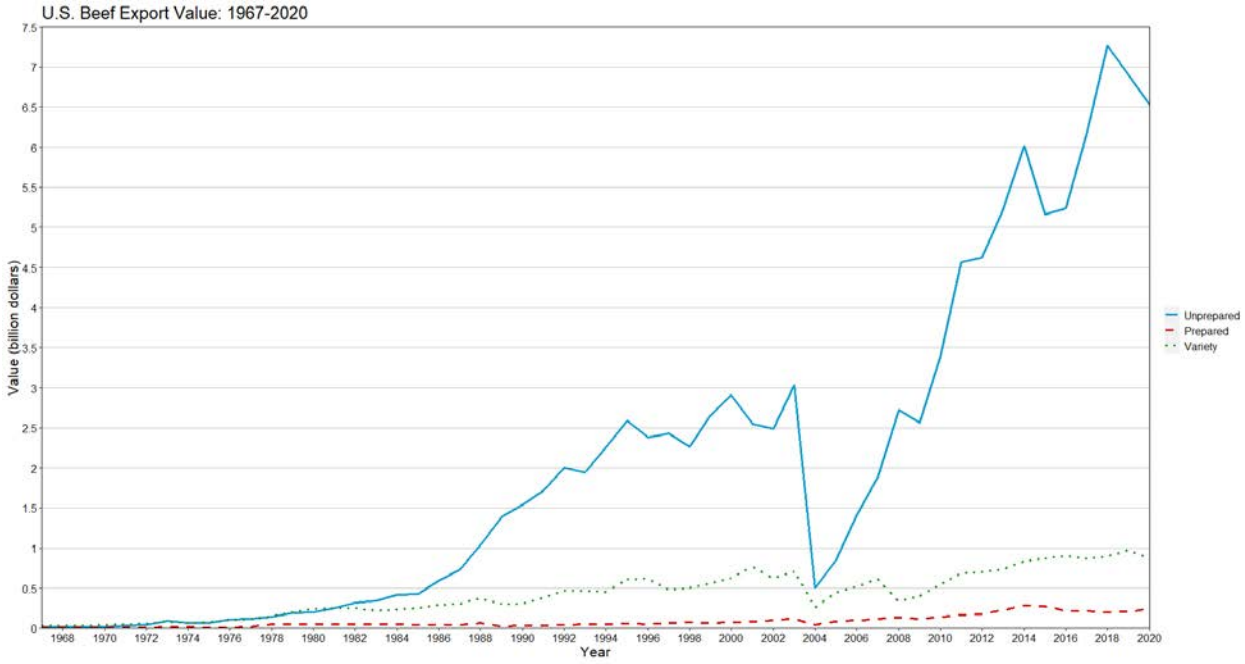
Exports

Beyond simple measures of volume traded, it is important to understand the monetary value of beef trade. To aid in this understanding, we again utilize USDA FAS data. Figure 37 depicts the value of annual U.S. beef exports from 1967 to 2020 for unprepared, prepared, and variety beef. Mirroring export volume, the value of exports increased notably through the 1980s and 1990s, driven primarily by unprepared beef. By 2003, the value of U.S. beef exports across all product types exceeded $3.8 billion. Corresponding to the late-2003 BSE event, 2004 total beef export value dropped to just over $800 million, a decrease of 79 percent.

It took six years for the value of U.S. beef exports to recover from the event, reaching nearly $4.1 billion in 2010. With the exception of mid-2010 cattle herd contractions and 2020 COVID-19 impacts, beef export value continued to grow post-BSE. In 2018, export value

reached historic highs around $8.4 billion, with 87 percent of this value coming from unprepared beef. Elevated levels dropped off slightly in 2020, with the U.S. exporting $6.5 billion worth of unprepared beef, $239 million of prepared beef, and $874 million of variety beef, for a sum total of $7.6 billion. However, with 2020 levels at just a 5.6 percent decrease from 2019, the value of beef exports did not experience the lasting impacts that may have been predicted in the spring months as the COVID-19 pandemic began.

Figure 37. U.S. Beef Export Value, 1967-2020

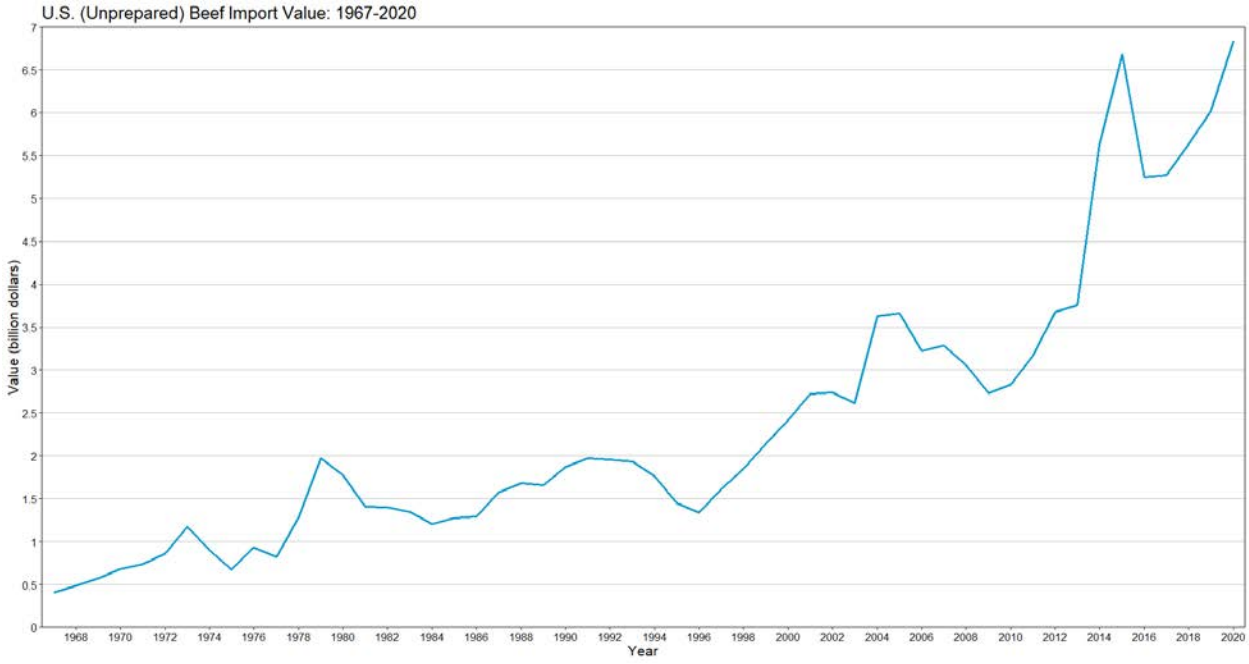


Imports

Now, we analyze historic trends in the U.S.' purchase of beef in the global market, with Figure 38 depicting the value of annual U.S. beef imports. Again, the USDA FAS reports imports for unprepared (fresh and chilled) beef only. The value of beef imports increased gradually from 1967 at $405 million to 2005 at $3.7 billion. Elevated value of imports in 2004 and 2005 again were the result of BSE-related production issues and the need to import beef at historically high levels.

Mirroring the trend of import volume, value of beef imports declined through the second half of the 2000s, bottoming out in 2009 at $2.7 billion, before rapidly increasing through the early-2010s as cattle inventories and associated domestic beef production declined. A 145 percent increase in the value of beef imports was experienced from 2009 ($2.7 billion) to 2015 ($6.7 billion). Following a brief dip in the volume (and value) of beef imports in the mid-to-late-2010s, the value of imports was again at historically high levels with the U.S. importing $6.8 billion worth of unprepared beef in 2020.

Figure 38. U.S. (Unprepared) Beef Import Value, 1967-2020



Implied Trade Prices

We forego breaking down the value of trade by partner, as we did in Figures 30 and 35 for volume, as the relationships of primary interest for trade value are generally identical to those of volume. However, to provide additional insight on net economic gain for the U.S. beef industry by participating in global trade, we compute an implied beef price for both exports and imports and some key, historically relevant trade partners. Implied price is simply the value of beef

traded divided by the volume traded. Figures 39 and 40 provide these implied prices for exports and imports of unprepared beef, respectively.

Figure 39. Implied U.S. (Unprepared) Beef Export Prices by Destination, 1967-2020

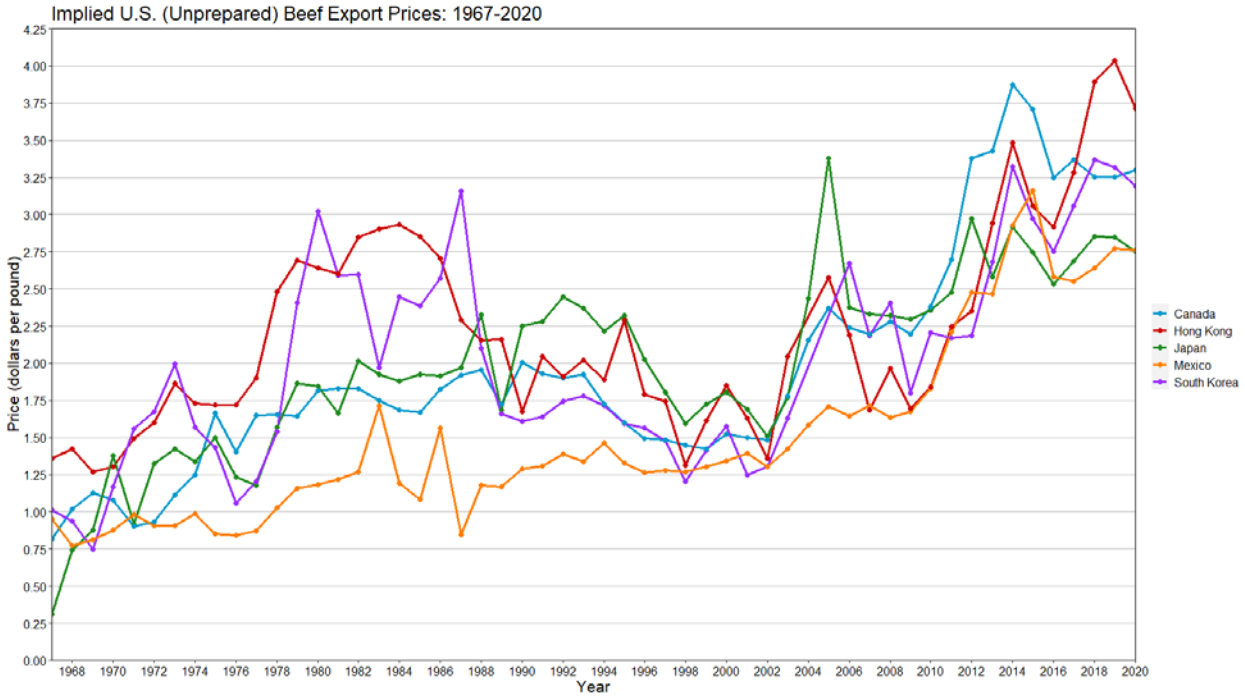
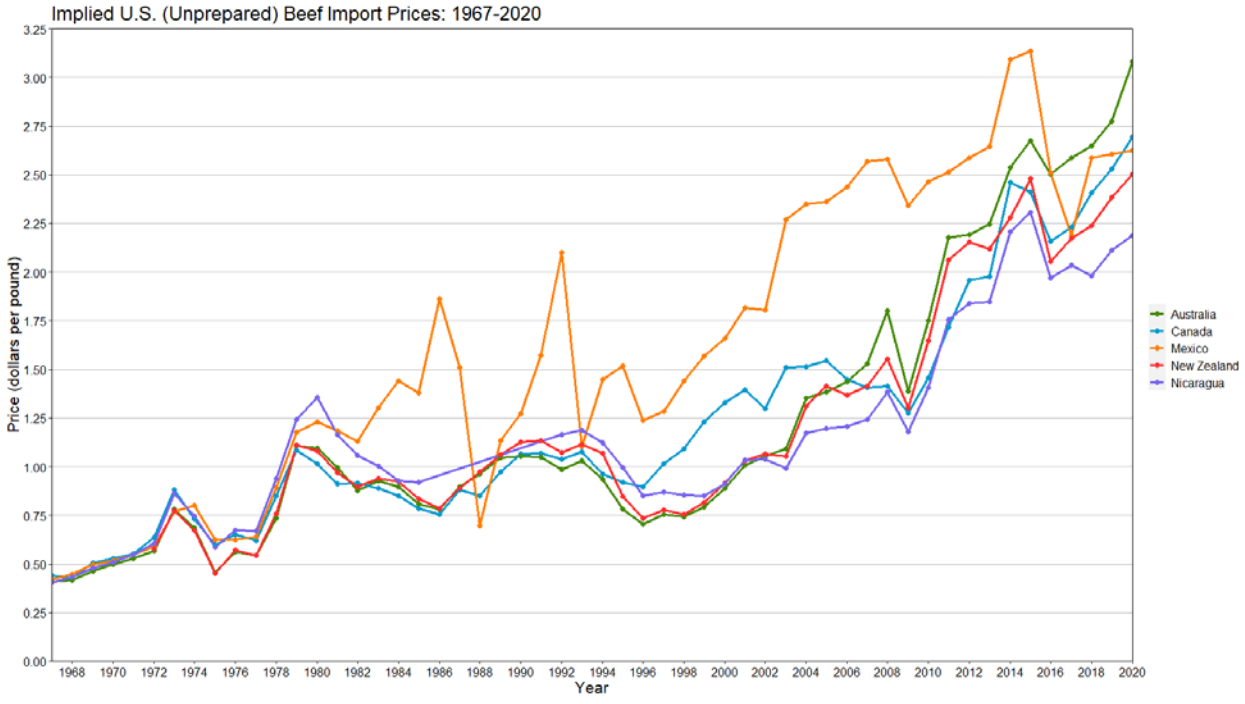


Figure 40. Implied U.S. (Unprepared) Beef Import Prices by Source, 1967-2020



Differences in implied trade prices between countries and across time could arise from varying types and quality of beef products traded, exchange rates, or costs of freight. In aggregate, the U.S. has historically experienced higher unprepared beef export prices than import prices but the value of exports and imports have been roughly equivalent, depicted in Figures 41 and 42. The take-home message is the U.S. exports less (unprepared) beef than it imports and receives a higher price than it pays such that aggregate export and import values are similar over time. In other words, the industry adds resources by exporting more valuable items than it imports, all else equal.

Figure 41. Implied U.S. (Unprepared) Beef Export and Import Prices, 1967-2020

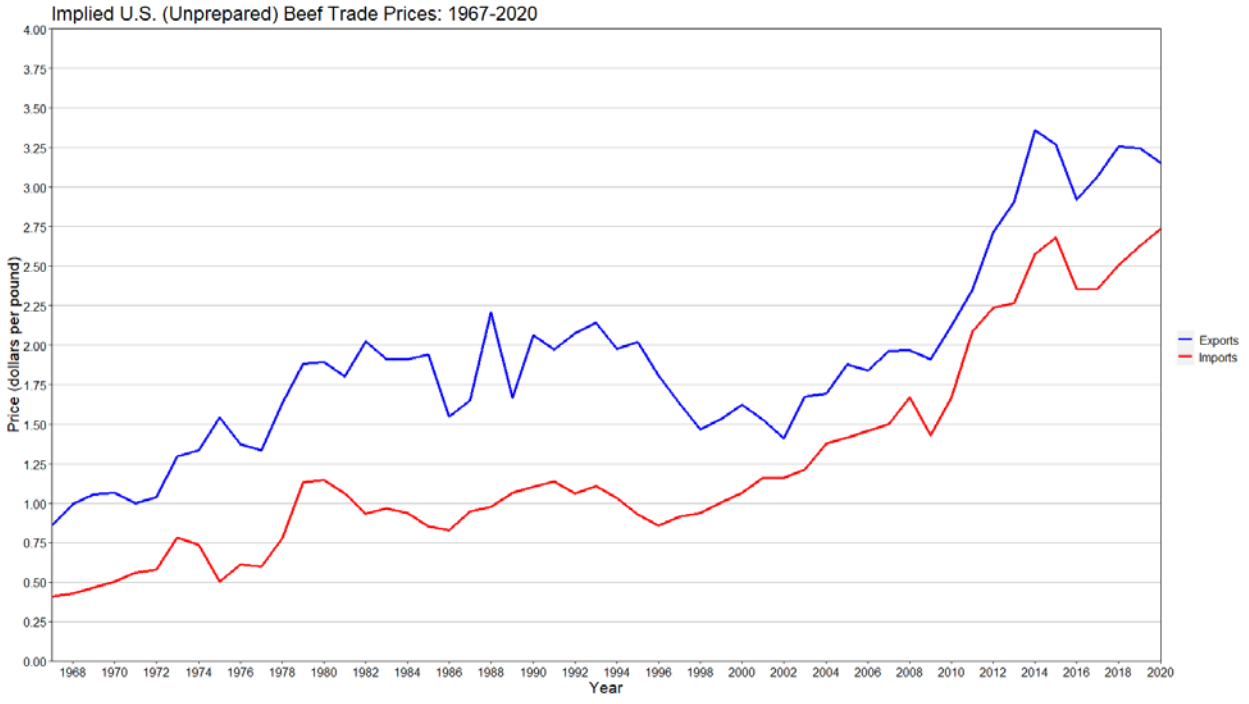
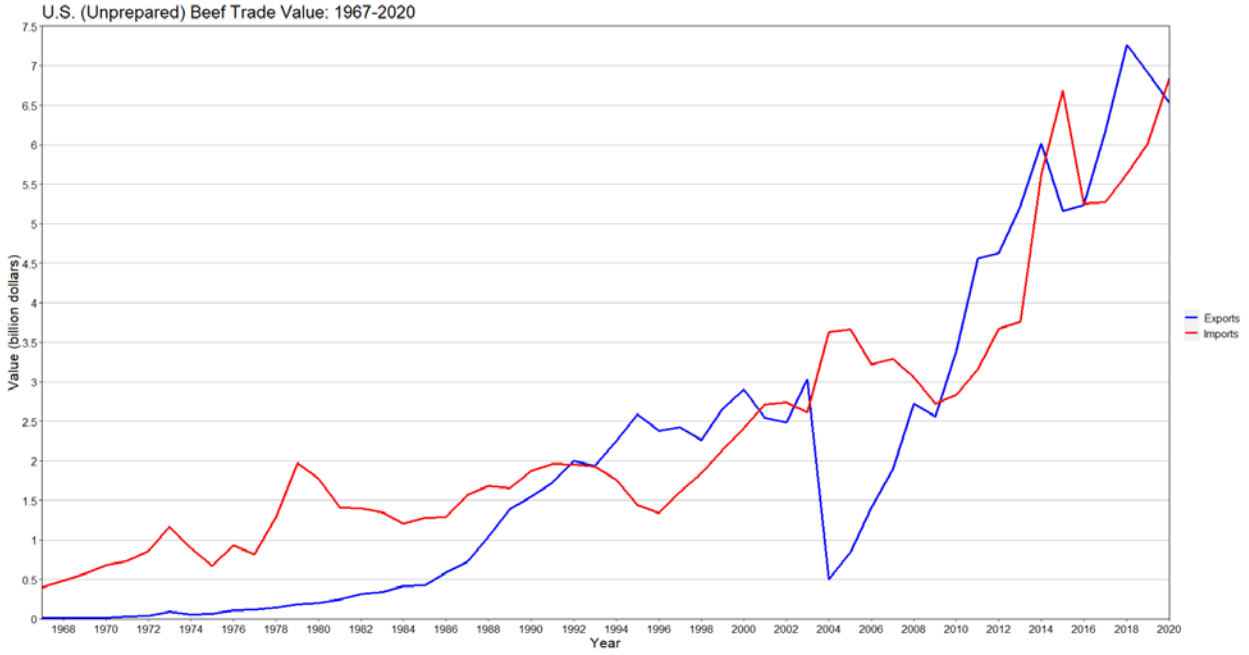


Figure 42. U.S. (Unprepared) Beef Export and Import Value, 1967-2020



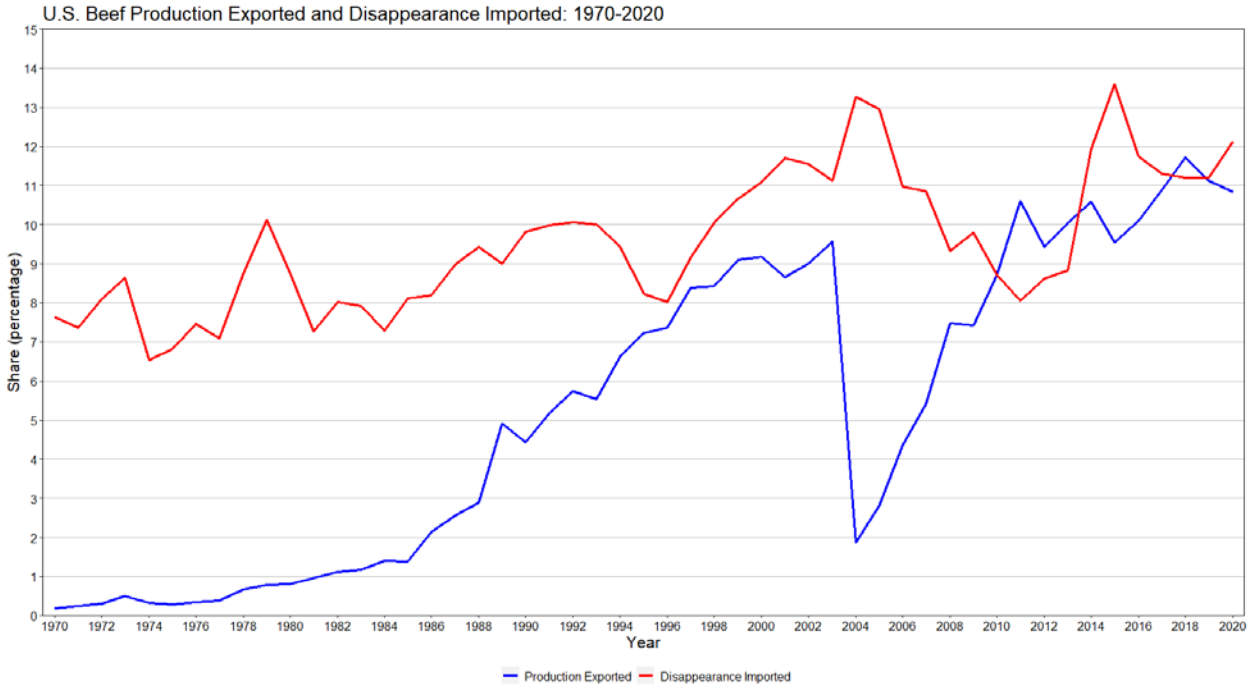
This trade situation has become more pronounced in recent years. From 2016 through 2020, the U.S. experienced average annual unprepared beef exports of 2,047 million pounds, export value of $6.4 billion, and implied export price of $3.13. Conversely, 2016-2020 average annual unprepared beef imports were 2,302 million pounds, import value was $5.8 billion, and implied import price was $2.52. Such trade statistics and implied prices indicate participation in the global market provides a net economic gain to the U.S. beef industry.

Share of Production and Disappearance Traded

Thus far, U.S. beef trade has been reported in terms of absolute levels (i.e., pounds or value exported and imported) without mention of its relative importance to the beef sector. To better understand the importance of trade, we compute the share of U.S. beef production that is exported and beef disappearance that is imported, depicted in Figure 43. The data used comes from a USDA Economic Research Service (ERS) compilation of World Agricultural Supply and

Demand Estimates (WASDE) reports, which contain information on U.S. beef production, consumption, exports, and imports since 1970.

Figure 43. U.S. Beef Production Exported and Domestic Disappearance Imported, 1970-2020



Beef disappearance coming from imports experienced historic highs of 13.3 percent in 2004 as the U.S. increased beef imports following the BSE incident, and 13.6 percent in 2015 as the U.S. again looked to the global market to offset low cattle supplies and associated declines in domestic beef production. However, even with these extreme events, the share of beef disappearance coming from imports has never exceeded 14 percent since 1970.

The share of domestic beef production exported consistently increased from 0.2 percent in 1970 to 9.6 percent in 2003. This share dropped to just under 2 percent in 2004 as many countries restricted imports of U.S. beef but witnessed rapid increases post-BSE. From 2016 through 2020, the share of U.S. domestic beef production that was exported hovered between 10

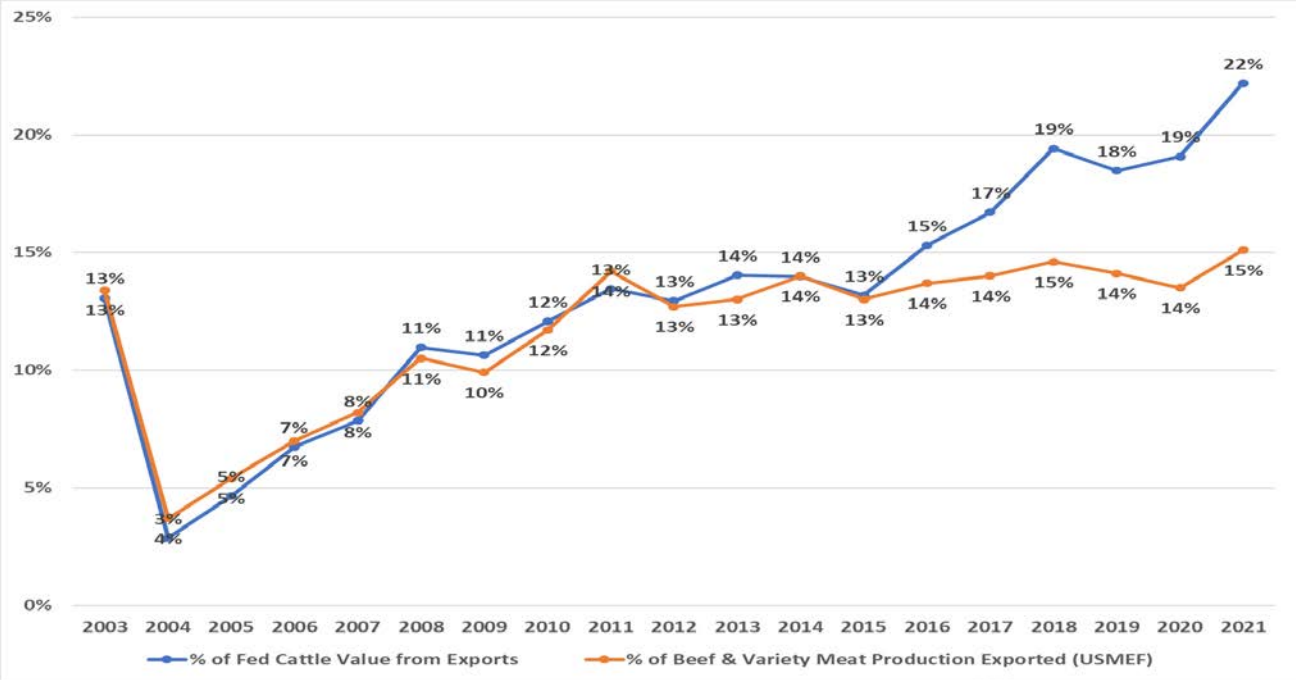
and 12 percent. Over time, exports have become increasingly important to the U.S. beef sector, while reliance on imports has remained comparatively steady.

Growing Economic Role of Exports

As a final summary point, we merge data from the United States Meat Export Federation (USMEF) and USDA AMS to provide direct context on the growing economic importance of beef and variety meat exports. USMEF provides annual estimates of the per head slaughtered value represented by beef and variety meat exports. This value hit a low of $30/head in 2004 following BSE challenges, grew to $300/head in 2014, hovered between $262/head and $323/head between 2015 and 2020, and through November of 2021 grew to $402/head. These $/head export value estimates can be compared to total sales value (using USDA reported average weight and 5-market average prices) yielding an estimate of the percentage sales revenue corresponding to exports. The resulting values are summarized in Figure 44.

As clearly shown in Figure 44, the economic role of beef and variety meat exports is substantial and growing. It is further important to highlight how since 2015 the percent of fed cattle value derived from exports has continued to grow relative to volume. For instance, current estimates for 2021 indicate 22% of fed cattle value is attributable to exports vs. only 15% of production (when considering both beef and variety meat). This is a classic example of demand growth and likely reflects increasing success in getting U.S. products in the hands of those most valuing them.

Figure 44. Role of U.S. Beef and Variety Meat Exports, 2003-2021 (thru Nov.)



V. National Market Impacts - EDM

As established multiple times in prior chapters, the sheer volume and value of beef trade makes any changes in U.S. beef exports and imports likely candidates for generating substantial economic impact. Accordingly, and consistent with this project's objectives, we consider the extreme case of losing U.S. beef export and import trade.

The methodological approach used here can succinctly be described as estimating changes in prices and quantities at market levels spanning the vertically linked beef-cattle industry as well as connected pork and poultry markets given the multi-species nature of protein markets. The exogenous market shocks considered here are a loss of U.S. beef exports and imports at the wholesale level. To estimate market impact on prices and quantities we employ an equilibrium displacement model (EDM). These price and quantity changes are used to approximate changes in producer surplus, a common economic impact measure derived from EDM results. The EDM utilized here is similar to that used by Tonsor and Schroeder (2015), Schroeder and Tonsor (2011), and other peer-reviewed studies and is further documented in said articles.

The EDM is composed of four sectors in the beef industry: 1) retail (consumer), 2) wholesale (processor/packer), 3) fed cattle (cattle feeding in feedlots), and 4) farm (feeder cattle from cow-calf producers).[6] To capture interactions between retail meat substitutes for beef we also include the pork and poultry markets. Reflecting the higher degree of integration relative to the beef industry, the economic model includes three pork marketing chain sectors (retail, wholesale, and fed cattle) and the poultry marketing chain is composed of two sectors (retail and

[6] Note this approach broadly uses retail to reflect all (grocery, food service, and institutional) domestic end users and uses "farm" to capture the broader feeder cattle sector comprised of cow-calf, backgrounder, and stocker operations. This reflects the availability of data and elasticity estimates and is consistent with many past research studies in the industry.

wholesale). International trade is explicitly incorporated in the model at the wholesale level for all three species.[7] The resulting framework is consistent with existing research and follows the work of Brester, Marsh, and Atwood (2004) and Pendell et al. (2010).

We simulate our model annually for ten consecutive years. This is consistent with historical beef cattle cycles and reflects an assumption that it takes the marketplace ten years to fully adjust from short-run to long-run relationships. Ten years of market effects were simulated by linearly adjusting all elasticities between short-run (year 1) and long-run (year 10) using elasticity estimates employed by Pendell et al. (2010).[8] Supply, demand, and quantity transmission elasticities used are equivalent to those used by Schroeder and Tonsor (2011). The market price and quantity values are annual averages for calendar year 2021 as reported by the Livestock Marketing Information Center (LMIC).

Traditionally EDM assessments are made when "small changes" are being considered. For instance, in applications of similar models Tonsor and Schroeder (2015) consider possible feedlot cost increases of under 1% if administering an E.coli vaccine, Schroeder and Tonsor (2011) consider feedlot production shifts less than 1% if adopting Zilmax in their rations, and Pendell et al. (2010) consider production cost increases less than 1% from adopting animal identification and tracing programs.

Since most applications of EDM models are for small shocks and the situation of interest here (loss of beef trade) can only be characterized as a large shock, we carefully take a two-stage approach. First, we consider a less (relative to 100%, complete loss) extreme situation and quantify cattle market impacts following a 10% reduction in both U.S. beef export and import

[7] The inclusion of trade at the wholesale level again reflects data quality and availability.
[8] Available at: http://ajae.oxfordjournals.org/content/suppl/2010/04/29/aaq037.DC1/aaq037supp.pdf

trade. We do this as we are more comfortable with the quality of resulting estimates given a 10% shock is closer than 100% to being "small" as often applied in EDM assessments. Given estimates for a 10% loss in beef export and import trade, we then discuss a 100% loss situation.

Results

Table 4 summarizes the changes in prices and quantities estimated by the EDM for the situation of U.S. beef export and imports each declining by 10% from 2021 levels. Fed cattle and feeder cattle quantities and prices all decline in each of the 10 years considered. This reflects the adverse shock from reduced beef trade and associated reduced derived demand for fed and feeder cattle. These impacts are largest initially when trade declines and normalize to smaller impacts over 10 years reflecting the model's presumption it takes 10 years for the industry to achieve a new market equilibrium. The 10% loss of beef exports and imports results in year 1 a price decline of -14.73% for feeder cattle and -7.98% for fed cattle compared to impacts in year 5 (10) of -1.32% (-0.50%) and -0.33% (-0.11%), respectively.

Table 4. Percentage Change in Endogenous Variables of EDM, 10% Loss in Beef Exports & Imports

Endogenous Variables	Year 1	Year 2	Year 3	Year 4	Year 5
Retail beef quantity	-3.73%	-2.42%	-0.87%	-0.47%	-0.30%
Retail beef price	4.40%	2.72%	0.94%	0.49%	0.31%
Retail pork price	0.29%	0.11%	0.02%	0.01%	0.00%
Retail poultry price	0.58%	0.05%	0.01%	0.00%	0.00%
Wholesale beef quantity	-6.90%	-6.07%	-2.72%	-1.73%	-1.29%
Wholesale beef price	5.49%	5.92%	2.81%	1.81%	1.33%
Slaughter cattle quantity	-5.54%	-6.58%	-3.76%	-2.88%	-2.47%
Imported wholesale beef quantity	-13.69%	-14.04%	-11.75%	-11.18%	-10.97%
Exported wholesale beef quantity	-12.31%	-14.18%	-12.79%	-12.31%	-12.09%
Imported wholesale beef price	-7.48%	-5.13%	-3.22%	-2.45%	-2.01%
Slaughter cattle price	-7.98%	-3.04%	-0.97%	-0.51%	-0.33%
Feeder cattle quantity	-3.24%	-4.47%	-2.68%	-2.09%	-1.82%
Feeder cattle price	-14.73%	-8.78%	-3.36%	-1.93%	-1.32%
Retail pork quantity	0.61%	0.41%	0.15%	0.08%	0.05%

Wholesale pork quantity	0.41%	0.31%	0.12%	0.07%	0.04%
Wholesale pork price	0.26%	0.13%	0.04%	0.02%	0.01%
Slaughter hogs quantity	0.18%	0.15%	0.06%	0.04%	0.02%
Imported wholesale pork quantity	0.27%	0.23%	0.10%	0.06%	0.04%
Exported wholesale pork quantity	-0.23%	-0.12%	-0.03%	-0.01%	-0.01%
Imported wholesale pork price	0.19%	0.10%	0.03%	0.01%	0.01%
Slaughter hogs price	0.43%	0.26%	0.09%	0.04%	0.02%
Retail poultry quantity	0.63%	0.48%	0.17%	0.09%	0.05%
Wholesale poultry quantity	0.66%	0.49%	0.17%	0.09%	0.06%
Wholesale poultry price	0.00%	0.00%	0.00%	0.00%	0.00%
Exported wholesale poultry quantity	-5.06%	-3.79%	-1.32%	-0.69%	-0.43%

Table 4. Percentage Change in Endogenous Variables of EDM, 10% Loss in Beef Exports & Imports (continued)

Endogenous Variables	Year 6	Year 7	Year 8	Year 9	Year 10
Retail beef quantity	-0.22%	-0.17%	-0.14%	-0.12%	-0.10%
Retail beef price	0.21%	0.16%	0.13%	0.10%	0.09%
Retail pork price	0.00%	0.00%	0.00%	0.00%	0.00%
Retail poultry price	0.00%	0.00%	0.00%	0.00%	0.00%
Wholesale beef quantity	-1.04%	-0.89%	-0.78%	-0.70%	-0.65%
Wholesale beef price	1.06%	0.88%	0.75%	0.65%	0.58%
Slaughter cattle quantity	-2.24%	-2.09%	-1.99%	-1.92%	-1.86%
Imported wholesale beef quantity	-10.88%	-10.84%	-10.81%	-10.80%	-10.80%
Exported wholesale beef quantity	-11.96%	-11.87%	-11.82%	-11.77%	-11.74%
Imported wholesale beef price	-1.71%	-1.49%	-1.32%	-1.19%	-1.08%
Slaughter cattle price	-0.24%	-0.19%	-0.15%	-0.13%	-0.11%
Feeder cattle quantity	-1.66%	-1.57%	-1.50%	-1.45%	-1.41%
Feeder cattle price	-1.00%	-0.80%	-0.67%	-0.57%	-0.50%
Retail pork quantity	0.04%	0.03%	0.02%	0.02%	0.01%
Wholesale pork quantity	0.03%	0.02%	0.02%	0.02%	0.01%
Wholesale pork price	0.00%	0.00%	0.00%	0.00%	0.00%
Slaughter hogs quantity	0.02%	0.01%	0.01%	0.01%	0.01%
Imported wholesale pork quantity	0.03%	0.02%	0.02%	0.01%	0.01%
Exported wholesale pork quantity	0.00%	0.00%	0.00%	0.00%	0.00%
Imported wholesale pork price	0.00%	0.00%	0.00%	0.00%	0.00%
Slaughter hogs price	0.02%	0.01%	0.01%	0.01%	0.00%
Retail poultry quantity	0.04%	0.03%	0.02%	0.02%	0.02%
Wholesale poultry quantity	0.04%	0.03%	0.02%	0.02%	0.02%
Wholesale poultry price	0.00%	0.00%	0.00%	0.00%	0.00%
Exported wholesale poultry quantity	-0.30%	-0.23%	-0.18%	-0.15%	-0.12%

Retail and wholesale beef prices increase in all 10 years as the efficiencies lost from prior trade activity pass vertically towards consumers in the form of more expensive beef. The quantities of wholesale beef exported and imported all decline over the 10 years evaluated. Observing these beef trade volumes decline by more than 10% reflects the market adapting. Narrowly underlying supply, demand, and quantity transmission elasticities in the model reflect the vertically-connected industry adjusting and ultimately reducing trade by more than 10% initially presumed (e.g. -12.31% exports and -13.69% imports in year 1) before settling in closer to 10% impacts in year 10.

The estimated changes in prices and quantities (table 4) following 10% loss of exports and imports can be used to derive an economic measure of producer impact – producer surplus (table 5).[9] The cumulative net present value producer surplus losses over ten years at the feeder cattle level are $12.90 billion and $6.75 billion at the fed cattle level.[10]

Table 5. Producer Surplus Change ($ millions), 10% Loss in Beef Exports & Imports

	Year 1	Year 2	Year 3	Year 4	Year 5
Slaughter cattle level	-4,324.86	-1,637.95	-533.47	-279.91	-181.71
Feeder cattle level	-6,342.49	-3,758.57	-1,448.91	-833.75	-573.72

Table 5. Producer Surplus Change ($ millions), 10% Loss in Beef Exports & Imports (continued)

	Year 6	Year 7	Year 8	Year 9	Year 10	Cumulative Present Value
Slaughter cattle level	-132.07	-102.81	-83.74	-70.44	-60.67	-6,749.02
Feeder cattle level	-434.11	-347.99	-289.89	-248.18	-216.84	-12,897.24

[9] Producer surplus is not the same as profit. Profit is total revenues minus total costs while producer surplus is revenue less direct or marginal cost. Accordingly, in the near term (e.g. year 1 of scenarios considered here) where fixed costs exist then producer surplus and profit differ while in the long term there are no fixed costs and the terms effectively reflect the same situation.

[10] This net present value calculation uses a 5% annual discount rate.

We can proceed to build upon the estimates for a 10% loss in trade to garner insights regarding a possible, 100% loss of both beef exports and imports. First, it is important to note the EDM approach is linear in parameters. Accordingly, one could take impacts from tables 4 and 5 above and multiply by a factor of 10. This results in a bottom-line economic impact estimate of, over 10 years, feeder cattle sellers losing $129 billion and fed cattle sellers losing $68 billion. We offer these estimates with a corresponding word of caution as EDM assessments are generally intended for "small change" situations (e.g. 1% shocks) and not "game changer" events such as the U.S. entirely ceasing beef trade.

Some additional insights are accordingly warranted. If the industry experienced a 10% loss of beef trade, we would expect "marginal" adjustments by many industry participants consistent with the intuition of supply and demand adjustments incrementally adjusting in the applied EDM. That is, the 10% exogenous shock situation aligns reasonably well with the conceptual intent of EDM applications. However, if a situation developed where the U.S. lost all 100% of beef exports and imports we reasonably would expect a different sequence of events. While all industry participants would adapt, many would likely entirely exit the industry and present changes that are not "marginal" or "incremental." This important difference is clarified here as the large adverse impacts of $129 and $68 billion for feeder and fed cattle sellers, respectively, are offered as the best available given currently available information and resources yet should be used with caution.

Stated differently, we are extremely confident in 1) the direction of prices, quantities, and producer well-being and 2) that catastrophic, industry-altering economic impacts would follow from complete loss of U.S. beef trade. We however are less confident in the exact precision of offered estimates.

Supplemental Context on National Impact Results

Given the magnitude of national impacts here, some additional context to frame these magnitudes can be helpful. A couple supplementary estimates are provided in this section.

A commonly held view is that higher beef imports are associated with lower revenues for cow-calf operators. To respond objectively to this, one can use insights on how beef imports impact cull cow and beef trim prices (see earlier chapter for related market details). Using univariate regression analyses we find that cull cow prices are more sensitive to beef trim price (+0.27 cross-price elasticity) than cull cow volume (-0.21 elasticity) highlighting the inner-industry economics behind targeting ground beef blending. This same analysis indicates, all else equal that a 100% decline in beef imports corresponds with a 40% decline in trim prices and a 100% decrease in beef imports results in 9% higher cull cow prices. The point here is that indirect impacts of beef imports on trim and ultimately calf crop value must also be appreciated in addition to direct impacts on cull cow values. Combining this recognition with calf crop revenue representing a much larger share (typically 80-85%) than cull cow revenue supports our finding that loss of imports is economically detrimental.

A second supplemental comparison is available by pulling together 2021 LMIC, USDA, and USMEF estimates to gain context on the current role of beef exports. Specifically, 2021 annual values of 33.8 million head FI slaughter, 1,471 live weight, and $123/cwt for fed cattle combine to approximate total fed cattle sales revenue was $61.3 billion in 2021. Meanwhile, USMEF approximates that through November, 22% ($402 of $1,811/hd value) of fed cattle value in 2021 came from exports. Combined this indicates for 2021 that $13.6 billion in fed cattle sales revenue corresponds with U.S. beef exports. If one takes this $13.6 billion estimate and discounts by 5% over 10 years, a “back of the envelope” estimate is that $104.97 billion in

fed cattle sales revenue is lost. This can be compared to $68 billion damage estimate from the EDM approach summarized above that reflects loss of both beef exports and imports yielding indirect support that while our EDM-based estimates indeed are large, they also are reasonable given the industry's size and underlying economic role of beef trade.

VI. State-Level Producer Impacts

The prior section yields measures of economic impact for the national cattle market. Given diversity in composition of the feeder and fed cattle sectors within the U.S. national market it is further useful to consider how these national impacts may be distributed across U.S. states. To facilitate this, we utilize USDA information available from the 2021 January Cattle Inventory report. Specifically, the 2021 January Cattle Inventory report contains estimates of the number of beef cow inventories and the number of cattle on feed for each U.S. state. We use these inventory estimates to approximate prevalence of feeder cattle and fed cattle market impacts that would occur in each state.

Table 6 presents resulting state-specific impact estimates of a 10% loss in both U.S. beef exports and imports for those selling feeder cattle (cow-calf and stocker/backgrounder segments) while table 7 provides parallel information for those selling fed cattle.

Table 6. Feeder Cattle Producer Surplus Change ($ millions) by State, 10% Loss in Beef Exports & Imports

State	Cumulative Present Value
AL	-288.51
AK	-3.02
AZ	-80.30
AR	-382.89
CA	-277.34
CO	-272.78
CT	-2.07
DE	-0.75
FL	-384.55
GA	-210.69
HI	-31.62
ID	-196.21
IL	-147.36
IN	-80.30
IA	-368.40
KS	-611.38
KY	-406.90
LA	-184.20
ME	-4.14
MD	-18.63
MA	-2.90
MI	-41.39
MN	-142.81
MS	-199.52
MO	-842.36
MT	-587.37
NE	-786.48
NV	-101.41
NH	-1.86
NJ	-3.56
NM	-191.65
NY	-39.32
NC	-153.16
ND	-403.59
OH	-125.01
OK	-906.10
OR	-217.32
PA	-89.00
RI	-0.41
SC	-69.54

SD	-744.67
TN	-372.54
TX	-1939.29
UT	-142.81
VT	-5.80
VA	-246.29
WA	-91.48
WV	-78.65
WI	-128.32
WY	-290.58

Table 7. Fed Cattle Producer Surplus Change ($ millions) by State, 10% Loss in Beef Exports & Imports

State	Cumulative Present Value
AL	0.00
AK	0.00
AZ	-121.60
AR	0.00
CA	-254.68
CO	-523.13
CT	0.00
DE	0.00
FL	0.00
GA	0.00
HI	0.00
ID	-137.67
IL	-105.54
IN	-52.77
IA	-536.90
KS	-1220.64
KY	-8.72
LA	0.00
ME	0.00
MD	-3.21
MA	0.00
MI	-84.89
MN	-183.55
MS	0.00
MO	-45.89
MT	-24.32
NE	-1248.17
NV	-1.38

NH	0.00
NJ	0.00
NM	0.00
NY	-10.10
NC	0.00
ND	-22.49
OH	-68.83
OK	-153.73
OR	-48.18
PA	-36.71
RI	0.00
SC	0.00
SD	-211.09
TN	0.00
TX	-1326.18
UT	-10.55
VT	0.00
VA	-7.34
WA	-110.13
WV	-2.29
WI	-114.72
WY	-33.96

By design in how national impacts are allocated to states by relative inventories - the states containing larger cattle inventories are expected to be impacted most by loss of beef trade. For instance, there are seven states with feeder cattle (cow-calf, stocker, and background considered broadly) sector losses exceeding $500 million over 10 years: Texas, Oklahoma, Missouri, Nebraska, South Dakota, Kansas, and Montana. An additional 10 states (for a total of 17) have losses over $250 million. Meanwhile, five states with fed cattle (feedlot) sector losses exceeding $500 million over 10 years: Texas, Nebraska, Kansas, Iowa, and Colorado.

Consistent with earlier comments, with noted caution state-level impacts of entirely losing beef exports and imports can be carefully approximated by multiplying estimates in tables

1 and 2 by a factor of 10. Doing so would indicate, over 10 years, for instance that feeder cattle sellers in Texas, Oklahoma, and Kansas stand to lose $19.4, $9.1, and $6.1 billion, respectively.

VII. Ending Comments

"*Trade is critical to America's prosperity – fueling economic growth, supporting good jobs at home, raising living standards and helping Americans provide for their families with affordable goods and services…. Trade keeps our economy open, dynamic, and competitive, and helps ensure that America continues to be the best place in the world to do business.*" These quotes are from the Office of the United States Trade Representative USTR (2022) and we fully concur. In the context of this report, we doubly believe these USTR remarks apply to the role of beef exports and imports in the U.S. The U.S. beef-cattle industry would be much smaller, less competitive, and ultimately less economically relevant at home and abroad if it was not persistently active in international beef trade.

It is often suggested that beef imports offset exports – a thought that a "pound of beef is a pound of beef." We hope the diversity in products and trading partners documented in this report help push back on this widely held notion. In truth, beef exports and imports work *together* to maximize the value of U.S. beef and cattle production and in turn support a larger, more economically viable industry. Hopefully the estimated impacts from losing beef exports and imports help drive this important point home.

Despite the well documented and growing importance of U.S. international beef trade, the level of detail available in currently accessible data remains limited. This is disappointing given the ongoing growth in volume and economic relevance of international trade not just for beef, but many sectors or U.S. agriculture. We encourage future support for corresponding enhancements to be considered. For instance, we believe there are very different market functions for whole muscle and ground beef items that could be better affirmed and hence understood with enhanced import data. This and other related increases in data quantity, quality,

timing, and detail could support further expanded and refined assessment. In turn, this improved assessment may drive enhanced understanding of the role of trade in the U.S. beef-cattle industry and perhaps, increased recognition of trade's role in the viability of the industry's future.

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IX. Appendix

FAS Data – Incremental Decade Summaries of Top Beef Trading Partners

Decade	Export Destination	Share of Exports	Import Source	Share of Imports
1967-1970	Bahamas, The	39.41%	Australia	40.50%
	Canada	27.81%	New Zealand	17.93%
	Bermuda	4.08%	Argentina	10.97%
	Jamaica	4.02%	Ireland	5.81%
	Japan	3.51%	Mexico	5.52%
	Other	21.17%	Other	19.28%
1971-1980	Japan	48.10%	Australia	47.10%
	Canada	20.08%	New Zealand	18.20%
	Bahamas, The	8.30%	Argentina	6.01%
	Bermuda	1.93%	Canada	4.43%
	Saudi Arabia	1.79%	Costa Rica	3.74%
	Other	19.80%	Other	20.52%
1981-1990	Japan	67.86%	Australia	43.78%
	Canada	9.33%	New Zealand	26.14%
	Mexico	4.54%	Canada	10.41%
	Brazil	4.38%	Argentina	5.87%
	Korea, South	3.70%	Brazil	3.76%
	Other	10.19%	Other	10.04%
1991-2000	Japan	50.50%	Australia	34.13%
	Mexico	15.26%	Canada	26.72%
	Canada	13.86%	New Zealand	23.55%
	Korea, South	12.67%	Argentina	5.01%
	Hong Kong	1.32%	Brazil	3.27%
	Other	6.39%	Other	7.32%
2001-2010	Mexico	33.51%	Canada	31.67%
	Japan	21.77%	Australia	30.98%
	Korea, South	14.28%	New Zealand	19.09%
	Canada	13.48%	Uruguay	6.43%
	Taiwan	3.39%	Brazil	5.05%
	Other	13.57%	Other	6.77%
2011-2020	Japan	24.39%	Australia	26.54%
	Korea, South	18.62%	Canada	25.08%
	Mexico	14.85%	New Zealand	18.78%
	Canada	11.20%	Mexico	16.23%
	Hong Kong	10.68%	Nicaragua	4.71%
	Other	20.26%	Other	8.66%

EDM Details

To estimate the market level impact of *E. coli* vaccination we employ an equilibrium displacement model (EDM). The EDM utilized here is similar to that used by Schroeder and Tonsor (2011). The EDM is composed of four sectors in the beef industry: 1) retail (consumer), 2) wholesale (processor/packer), 3) fed cattle (cattle feeding in feedlots), and 4) farm (feeder cattle from cow-calf producers). To capture interactions between retail meat substitutes for beef we also include the pork and poultry markets. Reflecting the higher degree of integration relative to the beef industry, the economic model includes three pork marketing chain sectors (retail, wholesale, and fed cattle) and the poultry marketing chain is composed of two sectors (retail and wholesale). International trade is explicitly incorporated in the model at the wholesale level for all three species. The resulting framework is consistent with existing research and most closely follows the recent work of Brester, Marsh, and Atwood (2004) and Pendell et al. (2010).

We simulate our model annually for ten consecutive years. Consistent with historical beef cattle cycles, we assume that it takes the marketplace ten years to fully adjust from short-run to long-run relationships. Ten years of market effects were simulated by linearly adjusting all elasticities between short-run (year 1) and long-run (year 10) using elasticity estimates employed by Pendell et al. (2010).[11] The supply, demand, and quantity transmission elasticities used are equivalent to those used by Schroeder and Tonsor (2011). The market price and quantity values are annual average values for calendar year 2021 as reported by the Livestock Marketing Information Center (LMIC).

[11] Available at: http://ajae.oxfordjournals.org/content/suppl/2010/04/29/aaq037.DC1/aaq037supp.pdf