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An Economic Chronology of Bovine Spongiform Encephalopathy in North America

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Abstract

The first confirmed cases of bovine spongiform encephalopathy (BSE) in Canada and the United States had significant effects on trade and prices of U.S. cattle and beef. However, these incidents occurred during a period of low U.S. beef supplies, near-record beef prices, and strong domestic demand for beef that was largely unshaken by the BSE announcement. Also, U.S. reliance on beef and cattle exports, roughly 10 percent of production, was not so great as to cause burdensome increases in domestic supplies. Increased regulations, however, imposed additional costs on beef production and processing sectors. Canadian cattle and beef are now able to enter the United States, though with some restrictions. U.S. beef exports to Japan resumed for a short time beginning in December 2005 but have been suspended since January 20, 2006.

Keywords: beef, bovine spongiform encephalopathy, BSE, byproducts, cattle, mad-cow disease, ruminant, trade

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North America's First Cases of BSE

Agricultural markets are more global and more integrated than ever before. In particular, Canada, Mexico, and the United States increasingly comprise an integrated North American market, largely because of the North American Free Trade Agreement (NAFTA) in 1994. In this environment, the consequences of a market shock in one arena are felt across agriculture and across international borders. One such shock was the discovery of bovine spongiform encephalopathy (BSE, also known as mad-cow disease) in the cattle herds of North America. As of April 25, 2006, Canada had confirmed five cases of BSE since May 2003 and the United States had confirmed three cases since December 2003. The economic effects of these cases were interspersed with a number of other events affecting the economy, making the task of sorting out BSE-induced effects from other effects difficult at best. These events were cast against a backdrop that included the 1997 U.S. and Canadian bans on feeding mammalian tissue to ruminants. This report presents a chronology of the economic implications of the first eight cases of BSE confirmed in Canada and the United States and the economic events and circumstances concurrent with these cases.

On May 20, 2003, Canadian officials announced that a BSE-infected cow was discovered in the province of Alberta. International borders with Canada closed immediately and trade partners stopped imports of all bovine products, live animals, and beef from Canada. Because Canada was highly dependent on exports—it shipped 47 percent of its beef production in 2002—this export ban had severe repercussions on the country's beef and cattle industry. The potential for other ruminants (sheep, goat, deer, elk, and buffalo) to be infected by BSE or similar brain-wasting diseases (see box “Bovine Spongiform Encephalopathy”) affected markets for these species. In the United States, the cessation of imports from Canada instantly reduced domestic beef supplies almost 4 percent. U.S. imports of beef in 2003 declined almost 7 percent from 2002 levels, and U.S. imports of live cows, fed cattle, and calves declined 30 percent. U.S. beef supplies were already tight because of drought-induced cattle inventory liquidation. These shortages exacerbated an ongoing price runup for U.S. beef and cattle that peaked in October 2003.

On August 8, 2003, the United States relaxed its ban on imports of Canadian beef, and limited trade between the countries resumed at a slow pace. In accordance with agreements made leading up to the August 8 milestone, U.S. beef imports from Canada were limited to boneless meat from animals less than 30 months of age at the time of slaughter. In the months following the August announcement, these boneless beef imports increased so that by October, the pressure on tightening U.S. supplies eased to the point that prices, having reached record-high levels, began to decline (fig. 1).

Although the United States resumed limited trade in beef from cattle under 30 months of age, the U.S. ban on imports of live animals from Canada remained in place. Prior to the ban, about 60 percent of U.S. live cattle imports came from Canada. These live-cattle imports from Canada entered the United States as cows to be slaughtered mainly for hamburger, as fed cattle for quality beef, and as feeder cattle for backgrounding¹ prior to going

¹Backgrounding includes those activities in which calves are grown prior to being placed on high-energy finishing rations in feedlots to grade USDA Select or better.

Bovine Spongiform Encephalopathy (BSE, or Mad-Cow Disease)

BSE, one of several central nervous system disorders referred to as transmissible spongiform encephalopathies (TSE), is a chronic, degenerative disease affecting the central nervous system of cattle. The incubation period usually ranges from 2 to 8 years. Most cases have occurred in dairy cows between 3 and 6 years of age. Following the onset of clinical signs, an infected animal's condition deteriorates until it dies or is destroyed. Currently, the disease can only be confirmed upon post mortem examination, and BSE has no cure or treatment. While over 95 percent of all BSE cases have occurred in the United Kingdom (UK), where the disease was first discovered in 1986, cases have been confirmed in most other European countries. Outside Europe, Japan discovered its first case in September 2001, followed by Canada in May 2003 and the United States in December 2003.

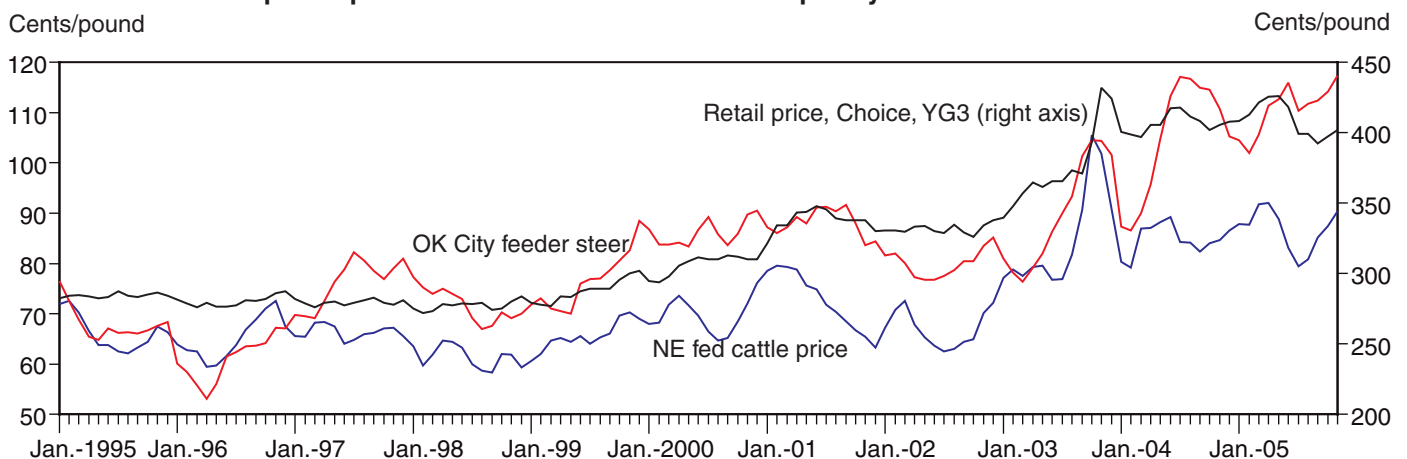
In 1996, UK scientists announced a suspected link between BSE in cattle and variant Creutzfeldt-Jakob Disease (vCJD) in humans. This event changed the view of BSE from an animal health issue to a human-health issue. As of May 28, 2006, 155 deaths attributed to vCJD had been reported in the UK. About 10 cases of vCJD have been found in other countries, of which 6 were linked to exposure in the UK. Many scientists suspect that humans contract vCJD by ingesting the causative agent, thought to be an abnormal prion or abnormal protein, in products made from brain, spinal cord, or other infective tissues from BSE-infected cattle (Lorains et al.).

BSE may have originally been caused by feeding meat and bone meal made from sheep infected with a mutant form of scrapie, a TSE in sheep. It is transmitted through contaminated feed and maternally. There is no evidence that BSE is contagious—it is not known to spread through contact between cattle within a herd, or from cattle to other species by contact.

Source: Adapted from Mathews, Bernstein, and Buzby.

Figure 1

U.S. cattle and beef prices peaked before BSE and recovered quickly



Source: Prepared by USDA, Economic Research Service using data from USDA, Agricultural Marketing Service and Department of Commerce, Bureau of Labor Statistics.

to feedlots or being placed directly on feed. Imports of Canadian cattle and beef help the United States maintain its position, along with Canada, as a unique supplier and consumer of most of the world's grain-fed, high-quality beef.

The United States was in the midst of its regulatory process for recognizing Canada as a minimum risk region for BSE when the second case hit North America on December 23, 2003. This time, the infected cow was found in the State of Washington but was traced back to a Canadian farm.² As protocol demanded, beef-importing countries banned U.S. cattle and beef products.³

The discovery of BSE in the United States significantly curtailed beef and cattle exports from the United States, triggering an increase in U.S. domestic cattle and beef supplies and a dropoff of domestic prices for cattle and beef (www.ers.usda.gov/news/bsecoverage.htm) (fig. 2). In addition to increasing the domestic supply of beef in the United States, the bans imposed by importers of U.S. beef also decreased domestic supplies in the countries enforcing the bans. These countries, notably Japan, Korea, and Mexico, three of the four largest U.S. beef customers at the time (Canada was the fourth), began looking to other suppliers for beef, primarily Australia, New Zealand, and South America. Canada, Mexico, the Philippines, and Poland were the first to develop protocols that allowed a limited list of U.S. beef products to enter, primarily boneless beef from cattle slaughtered under 30 months of age.

Shortly after the December 2003 discovery, the United States announced a series of new regulations and testing objectives designed to enhance protec-

²For a complete chronology of the December 2003 U.S. BSE case, go to http://www.usda.gov/wps/portal/!ut/p/_s.7_0_A/7_0_1OB/.cmd/ad/ar/sa.retrievecontent/.c/6_2_1UH/.ce/7_2_5JM/.p/5_2_4TQ/.d/1/_th/J_2_9D/_s.7_0_A/7_0_1OB?PC_7_2_5JM_contentid=bs_e_info_resources.xml&PC_7_2_5JM_navid=NEW_NOTEWORTHY. For recent updates, go to www.usda.gov/wps/portal/usdahome

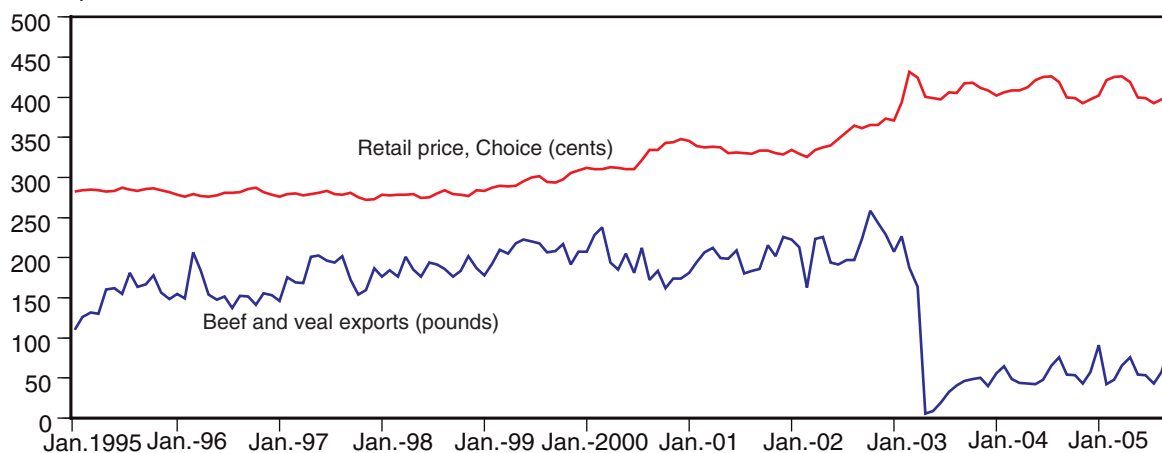
³These countries included Belize, Brazil, Canada, Cayman Islands, Chile, China (and Taiwan), Colombia, Costa Rica, Cuba, Dominican Republic, Egypt, Guatemala, Hong Kong, Indonesia, Japan, Korea, Kuwait, Malaysia, Mexico, Nicaragua, Peru, Republic of South Africa, Russia, St. Kitts, Singapore, Thailand, Ukraine, Uruguay, Venezuela, and Vietnam.

Figure 2

U.S. beef and veal exports plunged following the December 2003 BSE case

Million pounds

Cents/pound



Source: Prepared by USDA, Economic Research Service using data from U.S. Department of Commerce, Bureau of Labor Statistics.

tions against the spread of BSE and to reassure consumers that beef was safe to consume.⁴ Because these regulatory measures required slaughterhouses to remove additional products from cattle and find new uses for or means to dispose of the enhanced list of specified risk materials (SRM) and other materials banned from human or animal consumption, production costs and reduced revenues for beef and beef products. The regulations affected producers, processors, and consumers, depending on each level's ability to pass on the increased costs (Coffey et al.). The full effect of additional regulations will be felt over a longer period than will the effects of trade bans and price declines for cattle, beef, and beef products observed thus far.

In January 2005, Canada discovered two more BSE cases, and the United States confirmed a second case on June 24, 2005. The U.S. discovery brought to light the first case of BSE involving a native-born cow.⁵ The cow was born and raised on a ranch in Texas; that is, it had not been imported from Canada. The 12-year-old Brahma-cross cow was born prior to the implementation of the August 1997 feed ban⁶ that prohibits the use of most mammalian protein in ruminant feed. The animal was sold through a livestock sale in November 2004, died en route to a packing plant, and was then shipped to a pet food plant where it was sampled for BSE. The plant did not use the animal in its product, and the carcass was destroyed in November 2004. An initial rapid test on a sample from this cow was positive for BSE, but followup confirmatory tests with the immunohistochemistry (IHC) test were negative at the time. In early June 2005, USDA's Office of the Inspector General recommended that the tested sample and samples previously collected from two additional cows undergo an alternative test, the Western blot test.⁷ In March 2006, a third case, also involving a native-born cow estimated to have been 10 years old, was confirmed in Alabama. All three of the BSE-confirmed cattle in the United States were born prior to the 1997 feed ban put in place to prevent the spread of BSE (www.aphis.usda.gov/newsroom/content/2006/03/bsestatement3-13-06_vs.shtml and www.aphis.usda.gov/newsroom/hot_issues/bse/bse_al_epi-update.shtml). Despite a temporary interruption of trade with Taiwan following the June 2005 detection of BSE, some concerns raised by South Korea regarding the age of the Alabama cow, and international responses to the initial trade bans, U.S. consumer responses to each of the domestic BSE cases were muted.

Following publication of USDA's Minimum Risk Rule, U.S. imports of live cattle from Canada had been slated to resume on March 7, 2004, but this trade was stopped by a lawsuit and injunction brought against USDA on March 2, 2004, by the Ranchers Cattlemen Action Legal Fund (R-CALF). The organization challenged the legality of the rule proposed by USDA to again allow imports of live cattle from Canada, a country recognized by the World Animal Health Organization (OIE) as having animals infected with BSE (*R-CALF v. USDA*). In May 2005, the OIE announced a new set of country-risk categories for BSE status and products: "Negligible BSE Risk," "Controlled BSE Risk," and "Undetermined BSE Risk." The R-CALF injunction was stayed on July 14, 2005, and later reversed (July 25, 2005) by a three-judge panel of the Ninth Circuit Court of Appeals. On July 18, 2005, Canadian livestock began to cross the United States border for

⁴On January 12, 2004, USDA, Food Safety and Inspection Service published new rules enhancing its BSE safeguards to better protect public health. These measures included: (1) Banning from the human food supply all tissues that science tells us could be infective in a cow with the disease. These specified risk materials (SRM) include the skull, brain, trigeminal ganglia, eyes, portions of the vertebral column, spinal cord, and dorsal root ganglia of cattle age 30 months or older, and the tonsils and the distal ileum, (a part of the small intestine) of all cattle; (2) Instituting strict process controls for establishments using advanced meat recovery (AMR) systems for cattle younger than 30 months of age since SRMs are prohibited from use in AMR systems; (3) Banning nonambulatory cattle from entering the human food supply; (4) Holding the carcass of any animal chosen for testing out of the food supply until the test is confirmed negative and; (5) Prohibiting air injection stunning of cattle (www.fsis.usda.gov/oa/news/2004/bseregs.htm). U.S. Department of Health and Human Services, Food and Drug Administration (FDA) went further in closely related Interim Final Rules that banned from FDA-regulated human food, (including dietary supplements) and cosmetics: (1) Any material from "downer" cattle, animals that cannot walk; (2) Any material from "dead" cattle, those that die before reaching the slaughter plant; (3) Specified Risk Materials (SRM) that are known to harbor the highest concentrations of the infectious agent for BSE, such as the brain, skull, eyes, and spinal cord of cattle 30 months or older, and a portion of the small intestine and tonsils from all cattle, regardless of their age or health; and (4) Mechanically separated beef, which may contain SRMs, while allowing meat obtained by Advanced Meat Recovery (an automated system for cutting meat from bones) because USDA regulations do not allow it to contain SRMs. The FDA human food interim final rule was originally published in July 2004 (www.fda.gov/OHRMS/DOCKETS/98fr/04-15882.pdf) and amended in September 2005 (www.fda.gov/OHRMS/DOCKETS/98fr/05-17693.htm). Additional measures were announced later (October 2005) that proposed to prohibit the use of certain cattle origin

feeding and slaughter. These imports, limited to fed cattle under 30 months of age for immediate slaughter and feeder cattle that will be placed in feedlots and slaughtered at under 30 months of age, have gradually increased, and while the number of feeder and fed cattle now exceeds pre-BSE levels, total cattle import numbers remain below pre-BSE levels.

Effects of reduced beef supplies on U.S. beef importers have been significant, especially in Japan. The United States and Canada are the world's major suppliers of high-quality fed beef, exporting significant quantities to Japan. Most other countries, like Australia and New Zealand, export mostly lower quality, processing, grass-fed beef, and some Australian beef fed for short periods. Beef from BSE-free countries, like Australia and New Zealand, was not sufficient in quantity or similar enough in quality to completely replace U.S. exports to major trading partners. Brazil is unable to export beef to Japan because of confirmed cases of foot-and-mouth disease.

materials in the food or feed of all animals (www.fda.gov/OHRMS/DOCKETS/98fr/05-20196.pdf). However, a final animal feed rule has not yet followed.

⁵Based on the Harvard BSE risk assessment, the discovery of a native case of BSE in the United States increased the risk (relative risk) of more native cases of BSE in the United States. For more information go to www.aphis.usda.gov/lpa/issues/bse/harvard_10-3/text_wrefs.pdf and www.aphis.usda.gov/lpa/issues/bse/risk_assessment/mainreporttext.pdf.

⁶The feed ban was instituted by the U.S. Department of Health and Human Services, Food and Drug Administration to help minimize the risk that a cow might consume feed contaminated with the agent thought to cause BSE.

⁷For an explanation of the various tests, see the APHIS fact sheet, BSE Confirmatory Tests, at www.aphis.usda.gov/lpa/pubs/fsheet_faq_notice/faq_BSE_confirmtests.pdf.

U.S. Price and Supply Surprises

Annual increases in U.S.-Canadian-Mexican cattle and beef trade in the ten years prior to the first confirmed case of BSE in a native-born bovid in Canada and the United States added momentum to the reality of an integrated North American beef industry. Canadian cows were imported into the United States for breeding stock, dairy cow replacements, and for slaughter, where they provided lean processing beef for hamburger and other processed beef products. Dairy replacement heifers were imported, along with fed cattle for slaughter and feeder cattle for backgrounding on pasture prior to feedlot placement or direct placement into feedlots. Mexico, the second largest pre-BSE customer of U.S. beef, has long been an important source of stocker and feeder cattle for the United States.

In addition to the increasing live cattle trade, beef trade within North America also was increasing. In 2002, Canada exported some 47 percent of its beef production, with 81 percent of that going to the United States. Imports of Canadian beef and the beef derived from imported Canadian cattle for feeding and/or slaughter accounted for almost 4 percent of U.S. beef supplies in 2002. In comparison, U.S. exports of beef constitute about 10 percent of U.S. production. The dependency on beef imports varies considerably by importing country and by type of beef cuts, from very low for rear cuts (steaks and roasts) to extremely high for offal and processing cuts (table 1).

Data from two editions of the World Agricultural Supply and Demand Estimates (USDA, OCE)—one set published in December 2003, before BSE was confirmed, and one in January 2004, (shortly after the first U.S. BSE case)—provide an estimate of the magnitude of the effects analysts expected on

Table 1

U.S. beef exports, 2003

Quantities of U.S. beef exported to:							
Product	HS code	Japan	Mexico	South Korea	Canada	World	Share of total exports to J,M,SK,C
-----Metric tons-----							Percent
Fresh/Chilled beef	0201	151,930	183,158	30,573	56,992	434,854	97.2
Carcasses - whole/half	020110	488	1,435	177	0	2,528	83.1
Cuts - with bone	020120	5,264	10,761	1,270	4,447	23,595	92.1
Cuts - boneless	020130	146,178	170,961	29,126	52,545	408,731	97.6
Frozen beef	0202	144,088	19,168	175,957	6,221	397,981	86.8
Carcasses - whole/half	020210	271	464	156	0	1,625	54.9
Cuts - with bone	020220	13,884	1,394	82,025	1,134	108,776	90.5
Cuts - boneless	020230	129,933	17,310	93,776	5,087	287,580	85.6
Offal*	0206	52,664	57,159	23,970	16,042	283,075	52.9
Fresh bovine offal	020610	2,063	481	438	1,878	7,564	64.2
Frozen bovine tongues	020621	17,255	1,298	2,436	5,159	27,389	95.5
Frozen bovine livers	020622	3,762	3,878	743	868,482	90,607	10.2
Frozen other bovine	020629	29,584	51,502	20,354	8,137	157,515	69.6

*Offal from other species is included under HS 0206; only bovine products reported here.

Notes: HS = Harmonized System of trade codes. J = Japan. M = Mexico. SK = South Korea. C = Canada.

Source: Prepared by USDA, Economic Research Service using data from U.S. Department of Commerce, Bureau of Labor Statistics (www.usatradeonline.gov).

domestic livestock prices following the first reported case of BSE in the United States. Declines in monthly updated estimates of average quarterly prices of U.S. cattle ranged from about 4 percent (for cows) to 15 percent (for Choice steers) in the weeks following the announcement. Over the same period, hog prices (up 7 percent) along with poultry prices (up 1-2 percent) both increased.

The period from May 2003 through the first quarter of 2004 was marked by a series of events that affected U.S. cattle prices and supplies. First, the United States was in its eighth consecutive year of cattle inventory liquidation, nearing the end of a cattle cycle, so cattle and beef supplies were at cyclical lows. Consequently, prices were increasing. High prices and high demand for Choice beef, which was relatively scarce, spurred cattle feeders to market cattle early. This early marketing of fed cattle had the effect of reducing slaughter weights, which in turn reduced beef supplies.

The May 2003 closure of Canadian cattle and beef exports following the first Canadian case of BSE exacerbated the supply and price situation, not only in the United States, as Canada was the United States' primary external source for high-quality beef, but also worldwide, as Canada was one of two major suppliers of high-quality, grain-fed beef. Bans on importing the Canadian equivalent of USDA Choice beef increased international demand for U.S. supplies of Choice beef. Because of the first Canadian BSE case and the ensuing shortages of high-quality beef worldwide and in the United States, prices reached all-time record highs in October 2003.

U.S. imports of Canadian beef from cattle under 30 months of age had resumed in August 2003, and by October 2003, these Canadian imports had increased to near pre-BSE levels and prices began to decline. Despite the increase in imported beef from Canada, fourth quarter 2003 beef supplies in the United States was down 10 percent from a year earlier.

The discovery of the first U.S. case of BSE in late December 2003 in a cow imported from Canada almost instantly reversed the situation in the United States. As countries put in place bans on U.S. beef, the displaced exports boosted supplies of beef in the United States, and, as a result of the upsurge, prices continued to decline. Despite the BSE case and increased domestic supplies, strong domestic demand kept cattle and beef prices in January 2004 higher than they were in January 2003, although, no doubt, lower than they would have been without the U.S. case of BSE (see fig. 1).

The increase in U.S. hog prices following the Canadian and U.S. BSE cases in 2003 was surprising. While higher beef prices may have contributed to higher pork prices, record weekly supplies of pork contributed to increased total red meat supplies on the domestic market, and pork prices were expected to decline as a result. However, U.S. imports of pork were below earlier expectations due to a relatively weaker U.S. dollar. The weak dollar motivated foreign customers to buy U.S. pork, and exports increased. U.S. pork exports in 2003 were almost 7 percent higher than in 2002 and were expected to be higher for 2004 because of the continued weak dollar and the tendencies of consumers worldwide to substitute pork for other meat proteins during times of animal disease outbreaks (primarily BSE and Avian Influenza). Pork exports in 2004 were ultimately 27 percent higher than exports in 2003 (Blayney). The same was not true in sectors related to beef

production, like the byproduct, rendering, and feed sectors. Regulatory responses were swift and significant in terms of BSE-related costs to affected sectors.

Byproducts are an important source of income for meatpackers, renderers, and industries further downstream in the food supply chain. Price declines for byproducts affect prices received by packers, renderers, and cattle producers. The byproduct processing industry and the animal products rendering industry take byproducts produced during slaughter (portions of the cattle, pigs, sheep, poultry, and fish) and process them into many other products and secondary materials.⁸ Animal byproducts such as gelatin and collagen are used extensively in the cosmetic and pharmaceutical industries. Other animal byproducts (for example, enzymes, triglycerides, and isopropenyl esters) are used in the pharmaceutical industry and in the manufacture of fatty acids, paints, varnishes, rubber goods, plastics, and lubricants. The additional costs from increased regulations of byproducts accrue to these industries and their upstream suppliers of intermediate byproducts and offal.

In 2005, U.S. renderers produced over 8.2 million metric tons of rendered products, just under 2003 production and 3 percent below 2004 production (*Render*). However, in 2005, U.S. exports of rendered products totaled 1.43 million metric tons, about 10 percent below 2004 exports and almost 26 percent below 2003 exports. Most of the decline in exports was attributed to reduced exports of meat and bone meal. As expected, beef byproducts registered one of the largest changes in prices. Prior to discovery of the first U.S. BSE case, aggregate byproduct prices were in the US\$10.40 range (per hundred pounds). By February 2004, byproduct prices had declined to the US\$8.24 level, a 20-percent decline.

After processors remove edible meats and byproducts from the carcass, the remainder of the animal is rendered. The rendering process produces a protein fraction—meat and bone meal, bone meal, poultry meal, and some others—and a fat fraction—tallow, lard and yellow grease, among others. Rendered animal products may be manufactured into soaps, pet and livestock feed, fertilizers, lubricants, and other industrial products. Historically, tallow and lard were used in the cooking industry but have been mostly replaced by vegetable oils. Fats are the highest caloric-dense foodstuffs, and today rendered animal fats are used as livestock and pet feed ingredients, both domestically and as a product for export. Foreign markets use a large portion of animal byproducts and rendered products, lard and tallow in particular. In addition, as restrictions reduce the uses of these products, industries (and the environment) incur costs for disposal of SRMs affected by regulations imposed to stop the spread of BSE.

Meat and bone meal containing, or derived from, infected tissue is suspected to be the primary carrier of the infective abnormal prion causing BSE. In August 1997, FDA established a regulation that prohibits the use of most mammalian protein in the manufacture of ruminant feeds because the suspected infective abnormal prions are thought to be transmitted in meat and bone meal made from infected cattle. Protein manufactured from ruminants and other animals may still be fed to hogs and poultry because they are not affected by any known transmissible spongiform encephalopathy

⁸As of 2002, there were 122 rendering companies operating 231 establishments, down from 137 companies and 239 establishments in 1997. Most of these establishments have fewer than 100 employees. The U.S. rendering industry had a 2002 payroll of \$308 million and 9,093 employees (USDOD).

(see box). FDA estimated that this rule would ultimately cost the United States \$53 million (USHHS, FDA). This additional cost included \$44.3 million in direct compliance costs to beef, rendering, and byproduct industry sectors (including annualized capital and operating costs); \$171 million in lost value of products to the rendering industry (primarily a decline in value of meat and bone meal); and a gain of \$162.5 million, through lower feed costs, to producers of nonruminant animal.

Not only do the rendering and byproduct industries incur additional costs from additional regulations of byproducts, they and their upstream suppliers of offal and other byproducts can incur costs associated with disposal of newly restricted materials (Coffey et al.). After the confirmed BSE cases in May and December 2003, USDA and FDA introduced a round of Interim Proposed Rules that tightened the regulatory environment in further efforts to stop the spread of BSE in the United States. Coffey et al. estimated costs from regulations introduced in early 2004, just after the December 2003 discovery of BSE in the United States, at about \$200 million.

Most of the meat and bone meal fed in the United States is fed to nonruminants, mainly pets, swine, and poultry. Even before FDA imposed rules against feeding meat and bone meal to ruminants, only small amounts of animal proteins were fed to ruminants in the United States, primarily to dairy cattle. Range cattle, which are on pasture most of their lives, typically receive little protein supplement of any kind. In addition, in the United States, vegetable proteins (soybean meal, cottonseed meal, and distiller byproducts) and nonprotein nitrogen (urea) are more commonly fed to ruminants because they are cheaper sources of protein than animal-derived proteins, and cheaper nitrogen/protein sources can be converted to high-quality protein in ruminant stomachs (rumen). Most protein fed to cattle is fed to lactating dairy cows and cattle being fattened in feedlots during the final few months prior to slaughter.

In the European Union (EU), inadequate production of protein feeds and tariff structures on grains (Hasha) were such that animal proteins were more price-competitive with vegetable proteins. Producers made wide use of meat and bone meal in cattle feed rations before the feed ban, partially accounting for the widespread occurrence of BSE, particularly in the UK. However, even before the discovery of BSE in North America, some U.S. poultry producers had already voluntarily reduced their use of meat and bone meal in poultry feed rations in response to BSE-related problems in the EU, including the 1996 UK announcement of a possible connection between BSE and variant Creutzfeldt-Jakob disease in humans (see box “Bovine Spongiform Encephalopathy”). As the practice of feeding meat and bone meal to nonruminant livestock and pets declined in the United States, prices increased for substitute sources of high-quality livestock protein feedstuffs, like soybean meal, other oil seed meals, or other protein sources, depending on degree of substitutability. The increasing availability of distillers grains, byproducts from increasing ethanol production, at competitive prices will replace some other protein sources.

Effects of BSE on Canadian Beef Industry

Following Canada's announcement of its first BSE case, prices for cattle and beef in Canada fell immediately as countries around the world, including the United States, put in place bans on importing Canadian beef, beef products, and cattle. Canada provided extensive coverage of the government's investigation of the case as the unrealized exports of beef were put on the Canadian market. Canadian consumers continued to buy the increased domestic supplies of beef at lower prices.

Also, in August 2003, Canadian beef producers gained some relief as the United States partially lifted its ban by allowing imports of boneless beef from Canadian cattle slaughtered at under 30 months of age. As imported high-quality Canadian fed beef began to enter the United States in sufficient quantities to alleviate the shortage of Choice beef in the United States, U.S. prices for beef, beef products, and cattle reached record-level, peak prices in October 2003 and began declining. Thus, U.S. prices were already declining from their high point when the United States announced its December 2003 case of BSE. U.S. prices for beef, beef products, and cattle dropped by 15 to 20 percent in the days and weeks shortly after the December 23, 2003, announcement. That is, U.S. producers could not export beef, so prices in the very short run dropped. Actual factors behind the price drop include the direct effect of BSE on market psychology, the domestic market's inability to immediately absorb the quantities of beef of all qualities being pushed on the market, and the typical slowing trend of beef markets during the holidays. The degree of influence of each factor on the price decline remains unclear. Then, because domestic demand for the relatively scarce supplies of Choice beef, from an extended period of cyclical cattle inventory liquidation, remained strong, impacts of the BSE discovery on U.S. beef prices were short-lived. U.S. consumers responded similarly to Canadian consumers by continuing to eat beef, showing confidence in the U.S. beef production system and lower prices from market responses to BSE and increased domestic supplies of beef stemming from global import bans. As a result, economic impacts from consumer responses to the first U.S. case of BSE were also short-lived.

Impact of BSE Was Mitigated by Market Conditions

Prior to these North American BSE cases, analyses of the potential effects of BSE outbreaks based on the experience of other countries suggested more extreme effects on the U.S. livestock sectors (Mathews and Perry). Following the first outbreak, several factors helped mitigate the losses experienced by the affected U.S. industries, and, despite the significant trade losses, industry restructuring, and upstream- and downstream-related industry effects, the fallout has not been as disastrous for the United States as expected, given the previous experience of other BSE-infected countries.

First, the U.S. beef industry was in an extended inventory-liquidation phase of a cattle cycle that began in 1990. U.S. cattle inventories declined from a peak of 103.5 million head (January 1, 1996) to 94.9 million head (January 1, 2004), and, due to extended drought in many areas from 1998 to 2003, producers showed no signs of rebuilding inventories until January 1, 2005. Drought-induced record-high grain prices in summer 1996 factored into the motivation behind the cyclical cow herd liquidation, which began in 1996. Annual beef production in 2003 was 3 percent lower than in 2002. Low beef supplies arose from the following:

- Low cattle inventories
- The ban against Canadian cattle, beef, and beef products
- Weather-related problems for cattle feeders
- The reduced slaughter weights attributed to cattle feeders marketing fed cattle at lower weights due to historically high prices

Second, strong U.S. demand for high-quality, grain-fed beef, particularly Choice beef, resulted in relatively high prices by historical standards. Choice beef was in short supply despite the increased overall domestic beef supplies from banned exports. High prices and high demand for Choice beef, relatively scarce because Canada was the source for the United States, continued to draw fed cattle to market early, which had the effect of reducing slaughter weights. This, in turn, reduced beef supplies. Prices reached all-time record highs in October 2003 but had begun to decline prior to the U.S. BSE case (see fig. 1). Fourth quarter 2003 beef production was down 12 percent from a year earlier.

Third, while significant, the economic effects of discovering a case of BSE in the U.S. herd were not as severe or as long lasting as those in other countries that had outbreaks. On average, beef exports from the United States prior to the announcement of BSE were only about 9 to 10 percent of total U.S. beef production. With the domestic market in a high demand/tight supply situation, the increase in domestic supplies because of unrealized exports was more easily absorbed. In Canada, where pre-BSE exports accounted for about 47 percent of production, the domestic market could not absorb the increases in beef supplies following the discovery of BSE. Because beef not exported must be disposed of domestically, the increase in domestic beef supplies resulted in an upward revision of 2004 U.S. per capita beef consumption by almost 9 percent from pre-BSE forecasts (USDA, OCE).

Lastly, consumer responses in both the U.S. and Canada were much different from those in other countries where BSE has been discovered, especially Germany, Japan, and the U.K., where beef demand declined significantly after BSE announcements. Demand in the United States did not shift; that is, consumer response to BSE did not lead to reduced beef consumption at lower prices. In the same vein, U.S. pork and poultry demand did not shift because of the discovery of BSE. Pork consumption appeared little changed into the third quarter of 2005. The increase in pork production has not had any significant effect on average beef prices, primarily because of tight supplies of Choice beef. Consumer response was similarly muted after the second and third U.S. cases of BSE were confirmed in June 2005 and April 2006.

Borders Are Slowly Opening

U.S. imports of Canadian beef, boneless and from cattle slaughtered at under 30 months of age, resumed in August 2003, and Canadian cattle have been crossing the U.S. border since July 2005, following a lengthy regulatory and legal process. These live animals must go directly to slaughter or to a feedlot and then on to slaughter. They must be under 30 months of age at the time of slaughter. Over 500,000 Canadian animals entered the United States during the second half of 2005. About 100,000 head per month continue to enter the United States, which suggests that just over a million head will enter the United States in 2006 (USDA, ERSa). This volume continues to cross the U.S. border with virtually no response in either the Canadian or U.S. markets despite Canada's fourth and fifth BSE cases confirmed on January 22, 2006, and April 16, 2006, and despite the last three infected cattle having been born after the 1997 Canadian feed ban.

Cull cows exported for slaughter in the United States accounted for a significant portion of Canadian exports prior to the discovery of BSE in Canada in May 2003, but under current laws they may not be exported to the United States if over 30 months of age. These cows were vital to the operations of many meatpackers in the northern tier of States from the Pacific Northwest to New England. The loss of Canadian cattle for these plants caused many to close, some permanently, and others to shift, at sometimes considerable expense, to slaughtering other classes of cattle. Canada continues to work through the large inventory of older cows that it has been unable to export since May 2003 and reported a 2-percent decline in its total cattle and calf inventory as of January 1, 2006. January 1, 2006, cow inventories were 1 percent below January 1, 2005, but still 4 percent above January 1, 2004, inventories (USDA, NASS). The U.S. government is presently in the process of developing additional regulations that could allow imports of Canadian cattle over 30 months of age and/or their meat products.

In the 2 years following the December 2003 discovery of BSE in the United States, the U.S. and Japanese governments conducted negotiations over the resumption of beef trade. These efforts culminated in the Japanese Food Safety Committee's report to the Japanese government that U.S. beef represents minimal health risks if processors follow proper procedures. This report prompted the Japanese government to finalize arrangements to reopen the Japanese market to U.S. beef, and trade resumed on December 11, 2005. Trade hinged on a previously agreed on beef export verification system (October 2004), under which Japan would accept only U.S. beef that was boneless and came from animals under 21 months of age from which the specified risk materials had been removed. Trade with Japan was interrupted just over a month later when, in January 2006, a shipment of U.S. veal containing vertebrae violated the agreement of trade in only boneless beef.

U.S. beef exports to Japan in 2006 will likely be only a fraction of the level reached in the years prior to the discovery of BSE. Since December 2003, Australia has been Japan's main supplier of beef, and Australia is expected to compete fiercely for market share even after U.S. beef returns to the Japanese market. Lingering questions about the safety of U.S. beef remain

in the minds of some Japanese consumers, as reflected in a number of consumer surveys. While results from these types of surveys are often biased because of the way questions are phrased, one example, a Kyodo Press Agency poll in early December 2005, reported 75 percent of Japanese unwilling to eat U.S. beef (*Tokyo Shimbun*). Increasing prices on the Nikkei Exchange for shares of Yoshinoya D and C Stock, the restaurant company that sells a popular beef-on-rice dish for which marbled U.S. beef is considered superior to Australian and other sources of leaner beef, demonstrates a measure of support for U.S. beef in the Japanese hotel, restaurant, and institution market. Also, the relatively small numbers of animals in the United States that will qualify for export under the A40 carcass grading standard (a measure of physiological maturity evaluated by examining the degree of ossification of vertebrae), or whose age can be verified will likely limit exports to Japan at least through 2006. Canada also qualifies for beef exports to Japan under the new Japanese regulations, and Canada's national cattle identification system may help it identify more animals that satisfy the age requirements for beef exports to Japan. However, the age limitation has constrained Canadian exports to Japan.

Taiwan reopened its borders to U.S. beef in April 2005 and received sizable shipments in May and June of the same year. Taiwan accepts beef from animals under 30 months of age. However, confirmation of the second U.S. BSE case in June 2005 prompted an interruption of Taiwanese imports of beef from the United States, which was again lifted on January 25, 2006. In January 2006, Hong Kong, previously ranked fifth in imported quantities of U.S. beef and which had banned trade in December 2003, resumed trade in boneless beef from animals under 30 months of age. In January 2006, Malaysia, Singapore, and Thailand also lifted bans on imports of U.S. beef from cattle under 30 months of age that had been in place since December 2003. On May 30, 2006, Mexico announced that it would accept bone-in beef from the United States.

South Korea eliminated beef import quotas in 2000, and, by 2003, it had grown into the second largest export market for U.S. beef, after Japan. Like Japan, South Korea also banned U.S. beef following the December 2003 announcement of a U.S. BSE case. Trade policy changes are a politically sensitive subject in South Korea, as Korean agricultural organizations have been quite vocal in protesting trade liberalization in general. The outcry in late 2005 following the South Korean government's decision to allow additional rice imports makes reopening the beef market even more of a delicate matter. The South Korean market is on track to begin importing U.S. beef in 2006.

Timing Affects Economic Impacts

The first confirmed cases of BSE in Canada and the United States had significant effects on the U.S. beef industry, particularly with respect to trade and prices of U.S. cattle and beef. However, the U.S. case occurred during a period marked by low beef supplies, near-record prices, and strong domestic demand for beef, little of which changed following the announcement. Over the longer term, regulatory changes will likely impose some additional cost adjustments on the beef production and processing sectors. The world livestock sector has been adjusting to BSE since it was first described as a livestock disease in the United Kingdom in 1986, and countries continue to modify their livestock industries to mitigate possible disease transmission. Lesser U.S. reliance on trade in beef and cattle also limited the impact of BSE on U.S. beef and cattle industries, compared with the more export-dependent Canadian cattle and beef industries. In the North American market, Canadian cattle and beef are now able to enter the United States, though trade is restricted to cattle under 30 months of age for slaughter or feeding for slaughter at under 30 months. U.S. cattle imports for 2006 are projected at 2.2 million head (USDA, OCE). Well over 40 percent of these cattle are expected to come from Canada and include only cattle under 30 months old. In international markets, it may take years for U.S. exports to Japan and South Korea to return to earlier levels. Through 2003, these countries represented the two largest markets for U.S. exports of beef.

The North American beef and cattle sectors and associated upstream and downstream sectors continue to adjust to changes in products eligible for trade, a process already underway for almost 2 years but far from final. Key issues remain: bans on trade in cattle over 30 months of age, beef from animals over 30 months of age, and reopening those markets still closed. The aforementioned changes in the packing sector in the Northern-tier States stemming from the loss of Canadian cows for slaughter is but one facet of the structural changes underway. Shifts are also evident in the Canadian slaughter sector, which is now gearing toward cow slaughter and away from slaughter of cattle under 30 months of age, and in the dairy sectors of both Canada and the United States, with respect to trade in dairy replacement heifers. These changes are far from cost free and will have far-reaching implications for many products, industries, and sectors.

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