Chapter 4

International Trade of Meat/Poultry Products and Food Safety Issues

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Summary

As our food system changes at all levels (consumption, production, and trade), these changes alter the nature and incidence of food safety risks. Greater consumer affluence and awareness of food safety issues tends to lead to a greater demand for safety. The three case studies in this chapter represent food safety issues that affect international trade of high-value meat and poultry products. The first case study is of Bovine Spongiform Encephalopathy (BSE) or "mad-cow disease," which began in the United Kingdom (UK) and has caused regulatory changes affecting both imports and market access worldwide. This case study shows that while live cattle and beef exports from the United Kingdom were decimated by three BSE crises (1988, 1996, and 2000), and have not recovered, total European Union (EU) exports of these products have been far less affected to date. For a brief period of time after each of the three BSE crises, EU domestic consumption of beef declined sharply. While EU domestic consumption of beef has gradually increased back to its long-term trend, prices have not recovered, suggesting some shift in demand. During the 1996 crisis, BSE became a human health issue when a connection between BSE and a new human variant of Creutzfeldt-Jakob disease (vCJD) was announced in the UK. BSE has affected the rendering industry and, because bovine byproducts and rendered products are used as intermediate inputs in so many products, effects have spread to the cosmetic, feed, medical, pharmaceutical, and other sectors.

The second case study, chosen to represent microbial food safety risks, focuses on *Salmonella* and covers the issue of zero or near-zero tolerance for *Salmonella* in poultry imposed by some countries. The *Salmonella* case study shows that many countries have trade restrictions for *Salmonella* in poultry and these restrictions vary by type (specific products or processing), extent (inspections of slaughter facilities, production practices), and duration, making compliance challenging for exporters. The technical ability to monitor and detect *Salmonella* and other pathogens is increasing and has led to major concerns about the difficulties in meeting the increasingly stringent or near-zero tolerance standards for *Salmonella* imposed by some countries. Also at issue is the inconsistency between standards for domestic and imported poultry.

Some foodborne pathogens, including *Salmonella*, have the potential to develop resistance to drugs used in livestock production so that the association of livestock drug use with drug-resistant foodborne pathogens and drug residues have potential implications for international trade. The third case study examines that issue, again using *Salmonella* as an example. There is accumulating evidence that some pathogens are becoming resistant to antibiotics. Some countries (for example, in the EU) prohibit the low-level (subtherapeutic) use of certain antimicrobial drugs as growth promotants in livestock production or have proposed such prohibitions based on their perception that there is enough evidence linking livestock drug use and human antibiotic effectiveness in treating foodborne illnesses, including salmonellosis.

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Introduction

This chapter focuses on food safety concerns surrounding meat and poultry products and their associated impacts on international trade. These high-value products are widely traded internationally. The impacts from food safety concerns on meat and poultry trade are particularly important to the United States because of the high value and volume of U.S. exports of these products (table 4.1). U.S. exports of cattle, sheep, hogs, poultry, and many of their products account for roughly 10 percent of the value of cash receipts for those livestock species at the farm level. In terms of volume, about 20 percent of U.S. poultry production and 8.5 percent of U.S. beef production was exported in 2001. Although the United States is not a major importer of poultry, imports of meats and live animals are important, particularly imports of young live animals.

Table 4.1—U.S. livestock product exports and imports

	Fiscal year			
	2001	2002	2001	2002
	—1,000 units—		*—$ million—*	
Exports				
Animals, live	—	—	727	696
Meats and preps., excl. poultry[1] (mt)	2,442	2,590	5,193	5,113
Dairy products	—	—	1,121	1,031
Poultry meats (mt)	2,810	2,586	2,084	1,879
Fats, oils, and greases (mt)	1,049	1,339	320	454
Hides and skins, incl. furskins	—	—	1,933	1,776
Cattle hides, whole	—	—	1,437	1,121
Imports				
Animals, live	—	—	2,198	2,022
Meats and preps., excl. poultry[1] (mt)	1,600	1,656	4,091	4,187
Beef and veal (mt)	1,056	1,067	2,645	2,749
Pork (mt)	399	439	1,039	992
Dairy products	—	—	1,728	1,841
Poultry and products	—	—	258	317
Fats, oils, and greases (mt)	106	99	62	63
Hides and skins, incl. furskins	—	—	162	136
Wool, unmanufactured (mt)	21	12	53	31

[1] Includes beef, pork, variety meat, and processing.

Source: *Agricultural Outlook* Statistical Tables, February 2003, accessed March 27, 2003: *www.ers.usda.gov/publications/Agoutlook/AOTables/AOTables.htm*

In the short run, meat and poultry trade varies due to year-to-year fluctuations in supply and demand. Supply may be affected by factors such as exchange rates and animal disease incidents that cause temporary trade restrictions. Demand factors that affect meat and poultry trade include changes in tastes and preferences, population growth, responses to food safety issues, and growth in income. Imports and exports for a particular sector may increase simultaneously due to differences in the supply and demand for different types of products produced within that sector. For example, U.S. consumers tend to prefer white poultry meat, and consequently the United States tends to export dark poultry meat. In general, poultry markets are subject to a mix of trade and national regulations combined with traditional and nontariff barriers (Orden et al., 2002). Historically, nontariff trade barriers have also been important in markets for other meats.

Meat and poultry trade has increased over time, and continued increases are projected over the next few decades, both in the United States and worldwide. World exports of poultry have increased dramatically and now account for about 10 percent of world consumption (Orden et al., 2002). Of all U.S. animal and crop exports, red meat exports increased the most over the last two decades. The 5-year average volume of U.S. red meat exports rose over 300 percent between 1981-85 and 1996-2000.

In its 1999 report on Animal Agriculture and Global Food Supply, the Council for Agricultural Science and Technology projected growth in international trade for livestock and livestock products, especially meat products (CAST, 1999). Predicting a 63-percent increase in global demand for meat through 2020, the CAST report attributed 88 percent of the projected increase to developing countries, with China accounting for half of that increase. Two specific reasons were cited for this projected increase in global demand for meat. First, increased urbanization due to increasing populations and rising incomes have increased per capita demand for meat, milk, and eggs. Second, increased global demand for meat reflects the increased demand for high-quality protein to improve children's growth, cognitive development, and health in countries where consumption of animal products is traditionally low. Meanwhile, per capita consumption of red meat has declined in the United States (Haley, 2001) and in some other developed countries, although U.S. per capita consumption of poultry has increased (Regmi, 2001).

This growth in meat and poultry exports has been accompanied by several food safety disputes. From the perspective of the United States, perhaps the best-known market access problem arising out of a food safety issue is the 1989 beef hormone ban that adversely affected Canadian and U.S. exports of beef to the European Union (see box 4.1, "The Hormone Case…"). Other examples of food safety concerns negatively affecting U.S. exports of meat and poultry products include suspicion of *E. coli* on beef products exported to Japan and of *Salmonella* on poultry products exported to Russia. An example of how a food safety concern not endemic to the United States can still negatively affect U.S. production and trade is Bovine Spongiform Encephalopathy (BSE) in cattle and its potential link to variant Creutzfeldt-Jakob disease (vCJD). BSE is the focus of the first case study here, the second covers *Salmonella* in poultry products, and the third discusses drug resistance. These food safety issues have caused changes in policies and trade flows worldwide.

Food Safety for Meat and Poultry

Ensuring food safety for internationally traded meat and poultry is particularly challenging because these products are perishable and can be contaminated by a variety of food safety hazards. Meat and poultry, along with other raw foods of animal origin (i.e., raw eggs, unpasteurized milk, and raw shellfish), are the foods most likely to cause foodborne illness outbreaks (CAST, 1994, p. 32).

Meat and poultry can be contaminated during production processes in many ways. In addition to physical contaminants like bones, hair, and other items, meat and poultry can also be contaminated with hormones, drugs, and other compounds that can leave residues in food, or by pathogens that can pass from animals or the environment to humans through contaminated raw food products or processing steps (table 4.2). Of bovine products, ground beef poses higher risks from *E. coli* O157:H7 than whole cuts of meat. The nature of ground beef is such that one hamburger may contain meat from many cows so any existing contamination can be spread throughout a batch of hamburger, making thorough cooking even more important. Pathogens such as *E. coli* O157:H7 and *Salmonella* are commonly found in the gastrointestinal tract of animals and birds (Wells et al., 1998). Contamination of meat and poultry can occur during slaughter if the gastrointestinal tract is punctured or if there is contamination on the hides, feathers, and hoofs when animals enter the slaughterhouse (IFT, 2003; Feinman, 1979). During processing, poultry are eviscerated, then generally chilled in a cold water bath, and sprayed with a cleansing solution. The cold water bath is somewhat controversial because it can spread pathogens to previously uncontaminated carcasses. Beef animals are also eviscerated, and the carcasses are sprayed with a cleansing solution, but then they are air chilled rather than dipped in water.

In general, improvements in food safety, such as safe canning procedures, pasteurization of milk, and disinfection of water supplies have successfully contributed to the control of many foodborne diseases. Similarly, to improve meat and poultry safety, existing technologies, such as irradiation, and new technologies, such as steam pasteurization, continue to be developed, refined, and adopted.

Links Between Animal and Human Health

More than 200 known pathogens are transmitted through food and pose human health risks (Mead et al., 1999). Many of the more important foodborne diseases are caused by pathogens such as *Salmonella*, *Campylobacter*, *Clostridium*, and *Listeria*, some of which are zoonoses.[2] Additional diseases are thought to be zoonoses, but conclusive evidence demonstrating the animal and human disease relationship is missing (e.g., Johne's disease in dairy cattle and Crohn's disease in humans (Collins, 1995; Thoen and Williams, 1994)). Some pathogens have changed or evolved recently into much more virulent strains (e.g., *E. coli* O157:H7 and *Salmonella* Typhimurium DT-104). Some strains of these bacterial pathogens have the added threat that through genetic variations, they have developed resistance to some antibiotic drugs.

The links between animal and human health are complex. In addition to the direct food safety links, there

[2] Zoonoses are disease-causing agents in both animals and humans and which can be passed between the two.

Box 4.1—The Hormone Case and the WTO Dispute Panel

While there is some controversy whether the EU hormone ban is a measure to protect food safety or to protect EU beef producers, there is little doubt that it originated from consumer concerns about the effects of hormones on human health (Kerr and Hobbs, 2000). Roberts (1998) clarifies this point:

> The original ban was proposed in response to public anxieties that emerged in the late 1970s and early 1980s following widely publicized reports of 'hormone scandals' in Italy. In 1977, some northern Italian school children exhibited signs of premature development which investigators suspected was linked to illegal growth hormones in veal or poultry served in school lunches. Although exhaustive examination of possible causes of the abnormalities produced no concrete conclusion, a public furor rose over the use of hormones in livestock production. Then, in 1980, numerous supplies of veal-based baby food in Italy were found to contain residues of the illegal growth promotant diethylstilbestrol (DES), a synthetic hormone used as a feed additive to increase productivity in animal production (p. 386).

In response to these human health concerns, the European Commission (EC) banned the use of certain hormones for farm animals (Directive 81/602). In 1985, the EU further extended this ban to include all natural and synthetic hormones for growth promotion and prohibited imports of meat from animals using hormones (Directives 88/146 and 88/299). The import ban went into effect in January 1989.

In the only food safety disputes to advance to a World Trade Organization (WTO) dispute panel, the United States and Canada challenged the science basis for the EU ban on growth hormones in beef production. The EU's defense of its measure rested on its claims that the international standards for these hormones did not meet its public health goals and that the ban represented a precautionary approach to managing uncertain risks.

The WTO Appellate Body upheld the original panel's decision that the EU's ban violated the provisions of the Sanitary Phytosanitary (SPS) Agreement (Roberts, 1998). Both decisions affirmed the right of WTO members to establish a level of consumer protection higher than the level set by international health standards. The ban was nonetheless judged to be in violation of the SPS Agreement as it was not backed by an objective risk assessment (in violation of Article 5.1 and Article 3.3). The panel and judges also rejected the EU's use of the "precautionary principle" in its legal defense, as there is no explicit reference to this principle in the treaty. The SPS Agreement does recognize a *conditional* precautionary principle in Article 5.7, which allows countries to provisionally adopt measures "on the basis of available pertinent information" while seeking additional information "necessary for a more objective assessment of risk." However, the EU could not defend its permanent ban under this provision.

Significantly, the Appellate Body did overturn the panel's ruling that the ban violated Article 5.5, which requires countries to avoid variation in the levels of health protection provided by its SPS measures, if such variation results in discrimination or creates a disguised restriction on trade. The judges concurred with the panel that EU policies regarding the use of growth promoting substances in animals were "arbitrary and unjustifiable" as the EU allowed their use in pork. However, they disagreed that the ban was "a disguised restriction on trade," perhaps in deference to public anxieties that emerged in the late 1970s and early 1980s following widely publicized reports of illegal veterinary drug use in Italy and France. But although the Appellate Body was willing to acknowledge that the ban was originally motivated by "consumer concerns" rather than by protectionism, the overall outcome of the case suggests that the WTO will rule against measures based on popular misconceptions of risks as well as more overtly discriminatory measures.

The EU did not fulfill its obligation to bring its measure into compliance with the SPS Agreement by the May 1999 deadline, stating that it needed more time to complete risk assessments. The WTO consequently authorized the United States and Canada to increase tariffs on $128.1 million of EU exports until the EU complied with the ruling or provided compensation for the ban by lowering other trade barriers. The parties continue to discuss options such as increased market access for hormone-free beef and labeling, but the case has not yet been settled. Both the ban and the retaliatory tariffs remain in place.

Box authored by Donna Roberts (ERS) and Laurian Unnevehr (University of Illinois)

Table 4.2—Animal diseases or pathogens that have human health implications[1]

Disease/pathogen	Source	Foods affected	Human diseases or conditions beyond gastrointestinal symptoms	Annual fatalities in U.S.[2]	Comments
Prions					
Bovine spongiform encephalopathy (BSE)	Cattle	Brain, nerve tissue, eyes, ileum	Variant Creutzfeldt-Jakob's disease (vCJD)	0 (>115 worldwide since 1996)	BSE is always fatal in cattle as is vCJD in humans
Bacteria					
Campylobacter	Poultry, cattle, pork	Raw milk, poultry, beef, pork, shellfish	Reactive arthritis, Guillain-Barré syndrome	99	Leading cause of known bacterial foodborne illness in the U.S.
Escherichia coli O157:H7	Cattle	Ground beef, raw milk	Hemolytic uremic syndrome (HUS)	52	Children under 5 years of age are particularly vulnerable to this pathogen and to HUS
Listeriosis monocytogenes	Many birds, mammals, and other animals	Hot dogs, luncheon meat, and numerous other foods	Sepsis, meningitis, bacteremia, acute febrile gastroenteritis	499	Can cause stillbirths and spontaneous abortions
Salmonella (non-typhoid)	Poultry, cattle	Meat, poultry, milk, eggs, and numerous other foods	Reiter's syndrome, reactive arthritis	533	Second leading known bacterial cause of foodborne illness in the U.S.
Yersinia	Swine	Pork, milk, or milk products	Joint pain	2	Most infections are uncomplicated and resolve completely
Parasites					
Toxoplasma gondii	Swine and contact with domestic cats' litter boxes	Pork, insufficiently cooked hamburger	Chronic reactive arthritis, Reiter's syndrome, miscarriage, birth defects	375	The primary source of infection for animals is feed contaminated with cat feces and possibly with rodent tissues. 30 to 60 percent of adults in the U.S. have *Toxoplasma* antibodies

[1] According to the U.S. Centers for Disease Control and Prevention (CDC), more than 200 known diseases are transmitted through food. In the interest of space, this table is only a partial listing of source species, foods affected, and chronic complications.

[2]Annual human fatalities in the United States from all food sources provided by Mead et al. (1999) and by DEFRA (2002) for BSE.

Source: Adapted from CAST (1994), Frenkel (1990), Mead et al. (1999), Orriss (1997), Thoen and Williams (1994), and Reuters (5/15/96).

also appear to be tradeoffs between protecting human and animal health. For example, the use of antimicrobial drugs for livestock may protect animal health by reducing pathogens, but may pose some risks to human health through decreased effectiveness of some human antibiotics (CAST, 1994). However, scientific uncertainty surrounds these tradeoffs. Much remains unknown about the impacts of livestock drug use on human health. For example, while it is known that antibiotic use in livestock production can lead to an increase in the presence of resistant bacteria in livestock and farms, the actual origins of the resistant bacteria or the resistance factors are not known. Also unknown is the extent to which livestock drug use is responsible for human foodborne illnesses due to resistant bacteria.

Increased trade in livestock products also increases the risk of introducing pathogens or foreign animal diseases into countries. Risks from internationally traded products differ from risks from domestic products in at least one important respect. With livestock products produced and consumed domestically, any animal and human health concerns stem from endemic diseases or pathogens, and responses to problems are often established and ongoing or evolving. Diseases or pathogens introduced through internationally traded livestock products may not be endemic and may pose a whole new set of problems unfamiliar to the importing country.

Foreign animal diseases can threaten trade and the economic health of the importing country and some pose potential threats to food safety and human health. Recent examples, not all of which are food safety concerns, include the Canadian BSE outbreak in 2003, the exotic Newcastle Disease outbreaks in the United States in 2002, the 2001 Foot and Mouth disease (FMD) outbreak in the UK, the 1997 FMD outbreak in Taiwan, the Avian Influenza outbreaks in Asia since 1995 and, the Avian Influenza outbreaks over the last decade in the United States. Not all of the foreign animal diseases in these examples caused food safety issues per se, but they did disrupt international trade in livestock products, and, in the case of the highly pathogenic form of Avian Influenza in Hong Kong, caused human deaths (Cardona, 2003).

Case Study 1: Bovine Spongiform Encephalopathy (BSE)

Bovine Spongiform Encephalopathy (BSE) or "mad-cow disease" is a highly publicized food safety concern (see box 4.2). The associated human disease, a newly labeled variant of Creutzfeldt-Jakob Disease (vCJD), is believed to be caused by consuming BSE-contaminated meat. The BSE case study demonstrates how major changes in international trade regulations and standards for live cattle, bovine products, and many other products can result from a disease with a relatively low probability of infection but a high fatality rate. vCJD is always fatal and has caused over 115 deaths worldwide since 1996 (UK Dept. of Health, Sept. 9, 2002).

This case study chronicles three BSE episodes and their trade impacts on the EU (1988, 1996, and 2000). Because of data limitations on industry costs incurred to meet domestic and international food safety standards, trade volumes and values are used as proxies for measuring the effects from BSE.

The Issue

BSE is a major food safety concern for several reasons, including: (1) the uncertainty of exactly how the disease is transferred to humans, which means that we have limited knowledge of how to prevent it, (2) the uncertainty of the total number of BSE and vCJD cases, partly due to the long incubation periods in both cattle and humans, (3) the inability to destroy the "prion," the agent believed to cause BSE and vCJD, (4) the lack of a cure for BSE and vCJD, and (5) the ability to confirm the presence of the disease only through postmortem testing. As we shall see, BSE is also a major animal health issue affecting production, consumption, and trade.

While cases of BSE have been found in many countries, over 95 percent of all BSE cases have been in the United Kingdom (UK) (table 4.3).[3] Estimated total costs to the UK alone from BSE-related market losses and for slaughtering, disposal, and selective cull schemes are over $5 billion (Watson, 2000). The BSE case study is presented chronologically and analyzes the less obvious impacts of BSE during the last 15 years on the volume and value of EU beef exports. The EU is the third largest beef exporter (after the United States and Australia). Understanding the impacts of a crisis like BSE is complicated as countries have many ongoing trade programs to meet the various domestic goals. EU trade policies are particularly complex and the introduction of new countries into the EU over time complicates the analysis of trade data series. The case study also provides a general discussion on the effect that BSE has had on countries worldwide, both on countries where BSE is endemic and where it is not, and the effects on other sectors beyond livestock and beef.

The 1988 Episode: Emphasis on Animal Health Concerns

The first BSE episode occurred in 1988 with the discovery of about 2,500 cases of BSE-infected cattle in the UK. More BSE-infected cattle in the UK were

[3] No cases of BSE have been confirmed in the United States. A BSE risk assessment conducted by the Harvard Center for Risk Analysis and commissioned by the U.S. Department of Agriculture (USDA) shows that the risk of BSE occurring in the United States is extremely low and current early protection systems would prevent its spread here. Canada has experienced two cases of BSE, the first in 1993, and the second on May 20, 2003.

Box 4.2—Bovine Spongiform Encephalopathy (BSE) and Variant Creutzfeldt-Jakob Disease (vCJD)

BSE is a chronic, degenerative disease affecting the central nervous system of cattle. The incubation period usually ranges from 2 to 8 years, and most cases in Great Britain have occurred in dairy cows between 3 and 6 years of age. Following the onset of clinical signs, the animal's condition deteriorates until it dies or is destroyed. There is no vaccine or treatment for BSE.

BSE was first discovered in 1986 in Great Britain and, to date, over 95 percent of all BSE cases have occurred in the United Kingdom (UK). However, while there has been a decline in the number of newly identified cases of BSE in the UK due to recent prevention and control efforts, cases have been confirmed in other European countries with new cases discovered in Austria, Finland, and Slovenia in 2001. No cases of BSE have been confirmed in the United States in over a decade of active surveillance. There have, however, been two confirmed cases in Canada.

In 1996, government officials in Great Britain announced that there was a possible link between BSE in cattle and a variant of Creutzfeldt-Jakob Disease in humans (vCJD). BSE in cattle and vCJD in humans belong to the family of diseases known as the transmissible spongiform encephalopathies (TSE), which cause the brain to have a spongelike appearance when examined under a microscope. vCJD is rare, invariably fatal, and characterized by progressive deterioration of brain tissue. The precise link between BSE and vCJD is unknown. However, many scientists now believe that humans contract vCJD by ingesting the causative agent, thought to be a prion or abnormal protein, in products made from brain, spinal cord, and some other organs from BSE-infected cattle (Lorains et al., 2001). In particular, epidemiological data suggest that BSE may have originally been caused by feeding cattle meat and bone meal made from sheep infected with a mutant form of scrapie or from feeding cattle protein contaminated with a previously unidentified TSE. Changes in rendering practices in the early 1980s may have enhanced the causative agent's survival in meat and bone meal, resulting in the recycling of infected cattle back to cattle. This increased the size of the epidemic. BSE is transmitted through contaminated feed and maternally. There is no evidence that BSE spreads through contact between unrelated adult cattle (e.g., within a herd) or from cattle to other species by contact.

Currently, tests cannot detect BSE in living cattle or vCJD in living humans. Microscopic postmortem examination of brain tissue and tests for prion protein are the primary laboratory methods used to confirm a diagnosis. As of September 2, 2002, vCJD had caused 115 deaths in the UK (UK Dept. of Health, 2002), and there have been some deaths outside of the UK (e.g., in France and the Republic of Ireland). No cases of vCJD have been detected in the United States except for one individual who had lived in the UK.

BSE has had a substantial impact on the UK's livestock industry and has altered international trade patterns. As of May 30, 2003, 180,078 head of cattle on 35,796 farms had been diagnosed with BSE in Great Britain. These animals, herdmates, and progeny, totaling over 5 million head, were destroyed. Even though there have been no confirmed cases of BSE or vCJD in the United States, the threat of BSE has increased consumer concerns about food safety and has caused the United States to impose international trade restrictions and to increase expenditures for BSE surveillance and other measures in order to protect animal and human health.

Source: Adapted from Buzby and Detwiler, 2001.

quickly discovered, with over 7,000 additional cases in 1989 and a peak of 37,000 cases in 1993 (fig. 4.1). This BSE outbreak was not really considered a food safety issue at the time, and early trade restrictions were imposed largely in response to the effects of BSE on animal health. By mid-1989, Australia, Israel, New Zealand, Sweden, and the United States had banned imports of live cattle from the UK, while Canada, Japan, Morocco, and South Africa introduced requirements that live cattle imports from the UK be certified as BSE-free. These trade restrictions caused a significant decline in UK live cattle exports. By 1990, UK live cattle exports were little more than a fifth of their 1988 level and have never recovered (table 4.4). UK exports, however, constituted only a small share of EU exports even before BSE, and restrictions on UK cattle did not have a commensurate effect on either EU or world live cattle trade. Indeed, total EU live cattle

Table 4.3—Number of reported cases of BSE in cattle in the United Kingdom[1] and worldwide[2]

Country	Reported cases
United Kingdom	180,078
Ireland	1,274
France	829
Portugal	787
Switzerland	432
Spain	302
Germany	253
Belgium	113
Italy	88
Netherlands	60
Denmark	13
Slovakia	12
Japan	7
Czech Republic	5
Poland	5
Slovenia	3
Canada	2
Liechtenstein	2
Luxembourg	2
Austria	1
Finland	1
Greece	1
Israel	1

[1] Source: May 30, 2003, data from Department for Environment, Food and Rural Affairs (DEFRA)(2001), *www.defra.gov.uk/animalh/bse/bse-statistics/bse/general.html* accessed July 23, 2003.

[2] Source: Feb. 21, 2003, data from the Office International des Epizooties (OIE) website. See original table on OIE website for details and caveats about cases by year of confirmation: *www.oie.int/eng/info/en_esbmonde.htm*

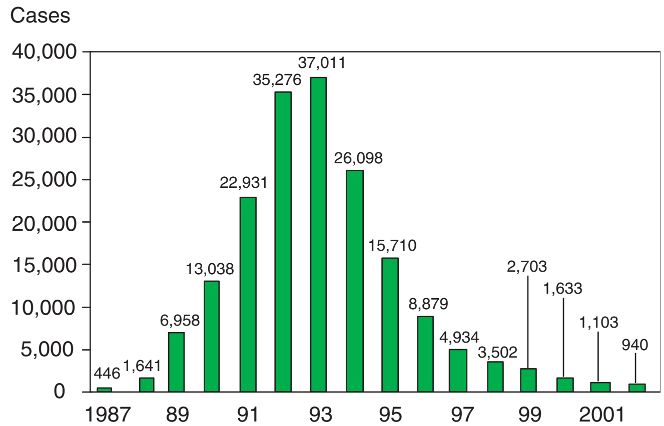
exports expanded between 1989 and 1996. Austria, Finland, and Sweden joined the EU in 1996, accounting for part of this increase (i.e., membership was 12 countries during 1988-1995 and 15 countries during 1996-2001).

The 1988 BSE outbreak also affected UK beef exports, but not as much as exports of live cattle. By early 1991, many countries had imposed bans on imports of UK beef, and other countries had placed stringent certification requirements on beef imported from the UK (e.g., Cyprus and Hong Kong).[4] One beef subcategory, UK exports of bone-in beef to other EU countries, showed a significant decline between 1990

[4] Countries that imposed bans include Algeria, Bahrain, Brazil, Canada, China, Egypt, Iran, Iraq, Jordan, Morocco, Saudi Arabia, Syria, Tunisia, Turkey, United Arab Emirates, and Russia.

Figure 4.1

Confirmed cases of BSE in the United Kingdom by year of clinical onset peaked in 1993



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and 1991, but then quickly recovered in later years, surpassing its pre-1988 levels.[5] UK exports of boneless beef also declined in the first few years after the 1988 outbreak, but had fully recovered by 1995.

The 1988 outbreak had little long-term effect on total volume of EU beef exports. While the volume of EU exports increased by 5 percent between 1988 and 1990, the value of these EU beef exports declined by almost 37 percent with most of the decline between 1988 and 1989, suggesting a downward shift in demand (table 4.4).

The 1996 Episode: A Switch to Human Concerns

The 1996 BSE episode began with the discovery of BSE-infected cattle in EU countries outside the UK (France, Ireland, and Portugal) and a March 1996 announcement of a potential link between vCJD and eating BSE-infected meat. By 1996, 13 vCJD cases had been reported in the UK. Media reports highlighted the slow, agonizing death suffered by vCJD patients as well as a perceived inability of UK and EU authorities to understand and control the spread of BSE and vCJD. Although, the number of newly confirmed BSE cases in the UK in 1996 was almost half of those discovered in the previous year (DEFRA, 2002), long incubation periods for BSE and vCJD

[5] The UK was never a large exporter of bone-in beef in any case.

Table 4.4—EU (excluding intra-trade) and UK (extra-EU) exports of live cattle and beef, 1988-2000

	Live cattle		Beef			
	EU[1]	UK	EU[1]	UK	EU[1]	UK
	— *Head* —		— *Metric tons* —		— *Million US$* —	
1988	60,627	315	615,360	27,475	1,945.4	75.6
1989	61,187	249	851,240	26,554	1,340.1	66.6
1990	68,212	66	647,059	16,457	1,230.9	33.4
1991	161,879	41	1,026,691	24,159	1,382.4	49.0
1992	169,447	82	972,385	19,789	1,472.8	50.2
1993	286,542	16	829,198	34,490	1,229.3	69.0
1994	295,830	31	784,609	45,931	1,259.0	85.0
1995	387,787	33	730,159	50,395	1,171.7	93.3
1996	501,828	0	727,848	12,535	1,167.9	23.2
1997	287,119	0	740,465	401	1,132.6	0.0
1998	266,225	0	521,789	151	888.3	0.0
1999	330,758	—[2]	694,054	165	1,018.1	0.0
2000	306,982	3	433,282	181	585.2	0.0
Nov-00	25,575	0	38,841	42	60.6	0.0
Dec-00	13,356	0	27,275	26	40.6	0.0
Jan-01	12,205	0	26,850	4	34.5	0.0
Feb-01	6,377	0	34,786	13	38.3	0.0

[1] Austria, Finland, and Sweden joined the EU in 1996. Therefore, data represent EU-12 during 1988-95 and EU-15 during 1996-2000.
[2] Number not confirmed.

Source: Eurostat and H.M. Customs and Excise.

caused concerns about how high human and animal illness tallies would reach.

Evidence of a link to vCJD quickly turned BSE from an animal health issue to a food safety issue. The EU temporarily banned all UK beef exports to other EU countries and the rest of the world. Additionally, most countries imposed a total ban on imports of beef and live cattle from the UK, and several countries also imposed either a ban on beef or live cattle from the EU or a ban on imports from those European regions where BSE was discovered. Between 1995 and 1997, UK exports of beef to non-EU countries dropped by 99 percent and exports to EU countries dropped by 97 percent. UK exports of live cattle, already at very low levels as a result of the 1988 episode, fell to zero.

Outside the UK, there were fears that the 1996 BSE episode would affect total EU and world beef consumption and trade for years, if not permanently. A series of media reports predicted that the sudden drop in beef consumption in some EU member states (sometimes by as much as 20 percent) would last for a long time and would quickly spread to other countries and regions outside the EU. Several international consumer, environment, and health advocacy groups implied that BSE in the EU was a sign of a large, worldwide epidemic and recommended eating other meats besides beef or switching to a more vegetarian diet.[6] There were fears that BSE could eventually spell the demise of the entire beef market.[7]

In retrospect, these fears were exaggerated. Total EU exports of beef barely declined in the first couple of years after the second episode (1996-1997) and sales from the world's major beef exporters either remained stable or increased over this time.[8] Not until 1998 did EU beef exports decline considerably, about 30 per-

[6] Examples include: (1) "Worldwide Meat Trade Might Have Spread Disease," *International Herald Tribune*, Dec. 23, 2000; (2) NOVA television program, "The Brain Eater," Aug. 17, 1999; (3) MSNBC report "Where's the Beef," March 23, 2001; and (4) *E-The Environment Magazine*, "The Case Against Meat," Jan./Feb. 2002.

[7] "Worldwide Meat Trade Might Have Spread Disease," *International Herald Tribune*, Dec. 23, 2000.

[8] World exports of beef and pork increased steadily between 1992 and 2000 (USDA, Sept. 2001).

cent, but that decline was due more to a downturn in the Russian economy than to any long-term decline in world import demand. In fact, world beef imports remained steady between 1995 and 2000. After 1998, as the Russian economy started improving, so did EU beef exports, increasing 33 percent between 1998 and 1999. The 1999 depreciation of the Euro also made EU export refunds less expensive and EU beef exports more attractive.[9] Although BSE spread to other countries both within and outside the EU from 1996 to 1999, the outbreaks were usually limited to one or two cases at a time and did not cause a worldwide panic until later in 2002, when new cases were identified in Japan and Israel.

Several reasons account for why the 1996 BSE episode had a much smaller and shorter-term effect on import demand and exports than some had predicted:

(1) Predictions of a large, permanent switch from beef consumption to consumption of other meats or a more vegetarian diet as a result of BSE were exaggerated.[10] While EU consumers are consuming more pork and poultry and less beef per capita over time, this trend is a gradual one. The source of this long-term trend is likely caused by long-term changes in the eating habits and demographics of EU consumers, and not driven primarily by food safety issues such as BSE and growth hormones (EC, 1997; EC, 1998). However, short-term changes in EU meat consumption may be caused by information about BSE and its associated risks described in the press (Verbeke et al., 2000; Verbeke and Ward, 2001).

(2) After the 1996 episode, the UK adopted an extensive set of programs to ensure that cattle used for beef production were BSE-free. These actions included the Over Thirty Month Cattle Slaughter Rule, which as the name implies, mandated that all cattle over 30 months of age be destroyed (BSE is not believed to affect cattle below this age) and a ban of all meat and bone meal (thought to be a carrier of BSE) in cattle feed. These actions led to fewer BSE cases in the UK from 1996 to 2001 (fig. 4.1). Many EU countries also adopted similar initiatives.

(3) During 1996-99, both EU beef consumption and production were below pre-BSE levels, leaving export quantities virtually unchanged. This helped stabilize the EU beef market.

(4) Prices for cattle and beef from the UK and the EU also declined, implying a downward shift in demand in response to risks associated with beef consumption. These price declines helped move products in markets that might otherwise have shown decreases in quantities traded (fig. 4.2 and table 4.4).

The 2000 Episode: A Widening Epidemic

The October 2000 BSE episode occurred just as EU initiatives to bring stability to the domestic beef market had started to be effective. Like the 1996 episode, the 2000 BSE episode was prompted by the discovery of more BSE cases in European countries outside the UK.[11] Also of importance, the first vCJD cases were discovered outside the UK in France and received a lot of media attention. The discovery of BSE in countries outside the UK was in part due to increased postmortem testing of cattle. By 2001, every EU country had reported at least one case of BSE.

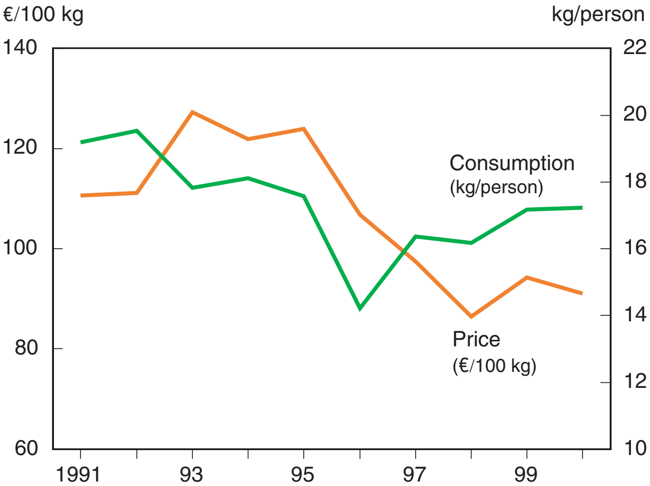
The trade effects from the October 2000 BSE episode were felt immediately. EU beef exports dropped 30 percent between November and December 2000, while remaining UK beef exports fell by almost 40 percent (table 4.4). Despite this being the third BSE episode in the EU, EU beef exports appear to have quickly recovered in the following months. Between January and February 2001, EU beef exports had risen almost to their pre-December 2000 levels. Even UK beef exports showed some signs of recovering during this period, although they were nowhere near their pre-BSE levels. The drop in EU exports during December 2000 did not

[9] The declining value of the Euro against many currencies reduced the export subsidy (difference between the world price and EU intervention price for beef) to practically nothing. This allowed the EU to export beef without fear of violating their WTO commitments on export subsidies.

[10] Adda (forthcoming) analyzed panel data from 2,798 French households before and after the March 1996 announcement linking BSE to vCJD (between Jan. 1, 1995, and June 24, 1996) and found no evidence of participants' becoming vegetarian, although households did reduce their expenditures on beef and switched to other animal protein substitutes.

[11] In 1996, Portugal reported 31 BSE cases, France reported 12 cases, and Ireland reported 74 cases of BSE. In 2000, Portugal reported 150 cases, France 162 cases, and Ireland 149 cases.

Figure 4.2
Nominal EU beef prices and consumption, 1991-2000



Source: OECD. Directorate for Food, Agriculture, and Fisheries.

cause a drop in world beef exports, as exports from the United States and Australia made up the difference. Measures added by the EU in January 2001 to ensure the safety of the beef supply may have helped dampen the impact of this crisis. For example, the Over Thirty Month Cattle Slaughter Rule was extended to other EU members and a ban was imposed on all animal feed (not just cattle feed) containing meat and bone meal. USDA's Economic Research Service (ERS) estimates that this EU ban on meat and bone meal feeding will cause the EU to import an additional 1.5 million tons of soymeal per year to replace meat and bone meal in livestock feed rations (USDA, 2002).

In February 2001, a major FMD epidemic broke out in the UK and spread to other EU countries, affecting EU trade of cattle, swine, and sheep and their products (Buzby et al., 2001; Mathews and Buzby, 2001). Because FMD is infectious through live animals and their products and countries typically stop exporting these products when FMD is confirmed, this FMD outbreak led to temporary market closures, affecting world exports and imports of these products (FAS, Oct. 2001). By the following month, EU beef exports had fallen by more than 80 percent due to FMD, a larger decline than during any of the three BSE crises.

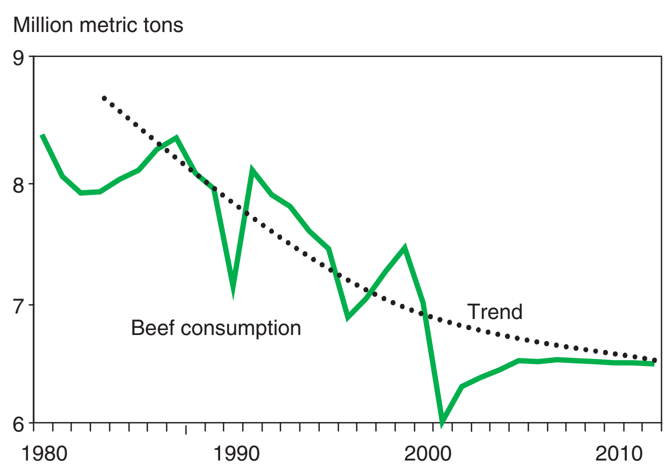
Conclusions From the BSE Case Study

Although UK exports of live cattle and beef plummeted to nearly zero as a result of the three BSE crises and have not yet recovered, the total volume of EU exports has been much less affected to date. Also, for a brief period of time after each BSE episode, domestic consumption in the EU declined sharply but then gradually increased to resume its long-term, downward trend (fig. 4.3). This longer-term trend in beef consumption began before the first BSE crisis. In essence, the effects of BSE on EU beef consumption and trade volumes were short-lived. Both the official USDA and European Commission forecasts predict a similar pattern for the future, estimating that long-term patterns in beef consumption and trade volumes for the next 6 to 8 years will not be greatly affected by BSE (see box 4.3) (EC, 1998; USDA, 2002).

EU beef prices, however, did not recover following the three episodes, suggesting a downward shift in demand for beef and severely affecting trade values. A number of studies provide additional evidence that consumer demand in the UK and EU has shifted downward due to BSE (Burton and Young, 1996; Verbeke, et al., 2000; Lloyd, et al., 2001; Verbeke and Ward, 2001; Henson and Mazzocchi, 2002). The 3-year average value of EU beef exports fell by 45 percent between 1988-90 and 1998-2000, largely because of the decline in prices (figs. 4.2 and 4.3).[12] Other factors also affected prices, including changes in EU country currencies associated with adoption of the Euro (Bowles, 2003). Jin and Koo (2003) found evi-

[12] Negotiations are currently underway to resume UK exports to Russia and Egypt, so UK exports may show improvement in the near future.

Figure 4.3
EU domestic beef consumption during the three BSE crises (1988, 1996, and 2000)



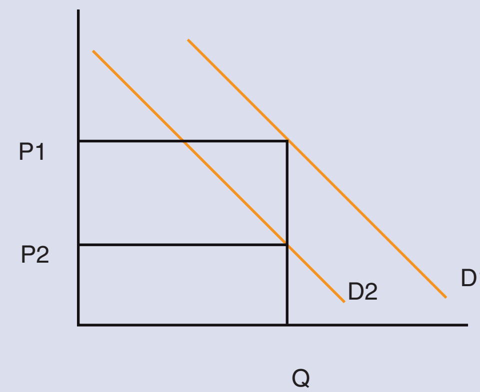
Source: USDA Production, Supply, and Distribution database, 1980-2001; baseline projections, 2002-2011.

Box 4.3—Consumption Versus Demand

Some distinctions should be made regarding consumption and demand. First, consumption and demand are not the same. For a commodity, consumption is production plus imports minus exports and net of changes in storage stocks. For example, all the beef that is produced and imported will be consumed (or exported or wasted) at some price. Beef production is generally stable due to cattle cycles and long production lags except for all but the most drastic changes in cattle inventories like the 30-month cull for BSE or the 2001 depopulation of livestock in the UK due to foot-and-mouth disease. If consumption remains relatively constant or continues on a downward trend, as beef consumption appears to have done in the UK, a quick glance at prices may give some indication about what is happening to demand. Demand is an economic term representing the quantity removed from the market for each price. Demand is affected by income, prices of substitute and complementary products, and other factors.

Recent studies have argued that while EU beef *consumption* may have recovered (Q below), beef demand has not (Thompson and Tallard, 2003). Significantly lower prices (e.g., a move from P1 to P2 in the figure below) for relatively similar quantities of beef consumption (Q in the figure below) indicate a downward shift in demand in the UK (Lloyd et al., 2001; Atkinson, 1999) (move from D1 to D2 in the figure). Earlier, Burton and Young (1996) attributed a "long-term" loss in UK beef's market share of 4.5 percent to the first BSE outbreak. Prices have not recovered relative to consumption. Whether the same demand shifts are observed for the EU has not yet been demonstrated in the literature.

Most economic forecasts do not predict any long-term trade or consumption effects from the BSE crises in the EU. However, these forecasts are based on the assumption that EU beef consumption has fully recovered or is fast approaching its long-term trend. If beef consumption is still short of what demand would have been in the absence of BSE, it would indicate that studies have underestimated the effects of BSE on demand and, consequently, trade that is, trade effects from BSE would be larger if demand were taken into account. More research needs to be completed on this topic.



dence for changes in consumer demand for beef in Japan, which they attributed to BSE, despite accounting for other factors, such as changes in importing countries' real income levels, third-country effects, and exchange rates.

Although some developed countries are changing their consumption patterns away from red meat (such as the United States and EU), world beef exports have increased during the past 12 years, largely due to middle-income countries' increasing their beef consumption (Regmi et al., 2001). This worldwide increased demand for beef along with price declines in the EU, indicative of a downward shift in demand in the EU, have moderated the decline in total EU beef export quantities. In general, fears of eating UK beef because it might be tainted with BSE have not spread to fears of eating beef from the EU. This is partly due to new EU efforts such as slaughtering schemes and feed restrictions that help assure consumers that the EU beef supply is free of BSE contamination. Nor have fears of eating UK beef spread to consumption of other livestock species.

BSE has caused countries to impose numerous additional safeguards to protect animal and human health. In addition to the Over Thirty Month Cattle Slaughter Rule and EU bans of meat and bone meal in all animal feed, BSE-related safeguards to protect animal and human health include surveillance systems, new regulations for domestic production, and international trade restrictions. Countries that do not have endemic BSE (the United States, for example) have also imposed regulations, import restrictions, and other measures to prevent the disease from crossing their borders and to mitigate its impact if it should be found. For example, as a result of BSE, the United States enacted a regulation prohibiting meat and bone meal in all ruminant feed. In addition to policy changes in response to BSE, markets have also changed. For example, U.S. beef exports to Japan have not yet recovered from Japanese consumers' responses to their domestic BSE outbreak.

In turn, as safety standards are raised worldwide, market access for some exports from both endemic and nonendemic countries has been affected. For example, EU regulations related to BSE are preventing the importation of U.S. gelatin into the EU until all U.S. production and inspection systems and measures are found to be equivalent to those in the EU (see chapter 3). This is occurring even though the U.S. has not had any cases of BSE.

In addition to gelatin, feed, livestock, and beef, BSE has affected many other sectors, including the rendering industry and cosmetic, medical, and pharmaceutical sectors. The indirect effects on so many other sectors occur because bovine byproducts and rendered products are commonly used as intermediate inputs in many products. Consequently, trade restrictions affect many sectors. Some of these restrictions are not supported by science. For example, many countries suspended imports of European dairy products following the 1996 BSE crisis and then later rescinded these bans when the World Health Organization and the International Office of Epizootics for animal and human health measures reaffirmed that existing scientific data did not identify these products as BSE vectors (see chapter 3).

Policy changes associated with BSE have resulted in significant disruptions to international trade. As discussed in chapter 3 of this report, the number of complaints (or counter notifications) to the World Trade Organization related to the regulation of transmissible spongiform encephalopathies, which include BSE, account for nearly half of all counter notifications related to food safety regulations since 1995.

Case Study 2: *Salmonella* and International Meat Trade

Unlike vCJD, which has claimed relatively few lives worldwide (115 in the UK as of Sept. 2, 2002, according to the UK Dept. of Health), foodborne pathogens cause an estimated 5,000 deaths annually in the United States alone, out of an estimated 76 million foodborne illnesses (Mead et al., 1999). Foodborne pathogens affect international trade through standards and regulations adopted by countries and sporadic bans on shipments of specific items.

In addition to other measures described later in this chapter, countries commonly use import bans to reduce food safety risks. Because the term "ban" is used in many ways, we make a distinction between bans and standards in this chapter. We use "standards" to refer to laws, rules, or regulations that establish the food safety standard for a country and that remain in place over time. An example of a standard is the requirement by some countries that all imported poultry must be cooked or canned. We use "bans" to refer to short-term or sporadic responses by a country to infractions of their standards; bans usually apply to specific shipments for specified periods. An example of a ban is the denial of access to a country of a specific shipment of poultry that tested positive for *Salmonella* contamination at the port of entry. Here, "bans" may also apply to narrow groups, a company for example.

World poultry trade for the 5 years ending in 2002 amounted to about 11-12 percent of world poultry production.[13] With meat and poultry consumption expected to increase in future years (CAST, 1999), this export share of world production will likely increase despite the divergent sanitary and phytosanitary (SPS) standards across countries and despite the likelihood that increased poultry exports will come from the few countries (Brazil, Canada, China, EU, Hungary, Thailand, and the United States) already exporting 80 percent of poultry and poultry products. The variety in SPS standards that importing countries impose on exporting countries has contributed to the number of disputes raised to the WTO SPS Committee (Orden et al., 2002). Complaints referencing poultry products accounted for 8 percent of total cross notifications raised within the first 5 years of the SPS Committee's authority (Orden et al., 2002). These disputes can disrupt trade.

While several types of pathogens have been identified in animal product imports and have resulted in trade interventions (e.g., *E. coli* O157:H7 and *Campylobacter*), *Salmonella* appears to be the most contentious in terms of trade disputes. For example, *Salmonella* is the only

[13] USDA, *Agriculture Outlook* Statistical Tables, table 23, *www.ers.usda.gov/publications/Agoutlook/AOTables/*, as accessed on April 17, 2003.

pathogen mentioned by name as a trade concern in poultry import requirements imposed by many countries. Therefore, this second case study focuses on *Salmonella* and its implications for food safety and international trade.

Each year in the United States alone, nontyphoidal *Salmonella* causes an estimated 1.3 million cases of foodborne illness, 15,608 associated hospitalizations, and 553 deaths (Mead et al., 1999).[14] The proportion of illnesses attributed to *Salmonella*-contaminated meat and poultry is unknown. More severe cases of salmonellosis tend to occur in the very old, the very young, and the immunocompromised. Human illness from foodborne *Salmonella* has a higher infection rate than vCJD but a lower fatality rate. *Salmonella*-related food safety issues are important to international trade for several reasons:

(1) *Salmonella* contamination occurs in a wide range of internationally traded animal and plant products, including poultry, eggs, beef, pork, dairy products, seafood, and fruits and vegetables.

(2) *Salmonella* is a common cause of foodborne illness worldwide and the second leading bacterial cause of foodborne illnesses in the United States, following *Campylobacter*.

(3) *Salmonella* is the leading cause of death attributed to known foodborne illnesses in the United States (Mead et al., 1999).

(4) Many countries impose *Salmonella* restrictions that limit trade in meat and poultry products.

(5) Such restrictions are sometimes inconsistent with domestic standards or are applied more strictly on imports.

(6) Some national standards are based on zero—or near zero—tolerances, levels that are difficult to achieve. These standards and restrictions are inconsistent between countries and lack a widely accepted scientific foundation.

(7) Countries vary in their commitments and resources allocated to reducing *Salmonella* at the various production, slaughter, and processing stages, which have spillover effects to trade. *Salmonella* is very difficult to control, although some countries, particularly Scandinavian countries, have invested large amounts of resources to minimize this pathogen in hog operations (Hayes et al., 1999) and in poultry (e.g., see Molbak et al., 1999, for Denmark). Developing countries have fewer resources to devote to reducing *Salmonella* in food production to meet strict tolerances. Additionally, countries may have reduced incentives to devote more resources to *Salmonella* reduction if other disease problems prevent them from exporting in international markets, such as endemic International Office of Epizootics (OIE) List A diseases (diseases with potential for rapid spread and serious socioeconomic consequences) (Seitzinger, 2002).

The primary issue in this case study concerns the range of importing countries' tolerance standards for *Salmonella* contamination in poultry. Because of data limitations, the *Salmonella* case study describes the pathology of the disease and the trade restrictions imposed by various countries.

Concerns About a Range of Tolerance Standards for *Salmonella*

The WTO Agreement on the Application of Sanitary and Phytosanitary Measures in April 1994 (see chapter 3) gives each WTO member the right to determine its own level of SPS protection. Countries impose different standards and regulations to handle the risks of pathogen contamination from processing and other stages of production. For example, U.S. producers commonly add chlorine to the cold water bath to reduce pathogen levels in poultry while some countries do not allow chlorine to be used for domestic or imported poultry. Countries' trade restrictions for *Salmonella* in poultry vary by type of restriction (by specific products or processing methods), extent (inspections of slaughter facilities, production practices), and duration of the trade interruption. For example, some countries require certification of slaughtering and processing facilities while others rely on exporters' domestic inspection systems. These diverse national standards make compliance challenging for exporters, particularly if the standards have zero or near-zero tolerances for *Salmonella*.

[14] Salmonellas are divided into two groups in the human health literature, typhoidal and non-typhoidal. Typhoidal *Salmonella* causes typhoid fever, a disease associated with contaminated water and poor sanitation, while other salmonellas cause foodborne illnesses. There is also a group of salmonellas that causes diseases in birds or animals, but not in humans.

Two main concerns arise when countries impose near-zero or zero tolerances for *Salmonella* contamination in imported meat products, especially poultry. First, a zero risk may not be feasible from either a policy or producer standpoint. In the case of *Salmonella*, a zero-risk policy may keep out all imports. Some scientists believe that *Salmonella* is ubiquitous in the environment and that continuous testing will find it, particularly with increased precision of diagnostic tools. Second, for most risks, the cost to achieve further risk reductions increases as the risk level approaches zero. Costs of preparing poultry products to meet zero-tolerance import standards of some countries would be in addition to costs incurred from the implementation of Hazard Analysis and Critical Control Point (HACCP) measures required of U.S. federally inspected meat and poultry processors and slaughterhouses (USDA, July 25, 1996).[15] As part of HACCP, USDA's Food Safety and Inspection Service (FSIS) tests raw meat and poultry products for *Salmonella*.

The range of standards can be seen in FSIS library of countries' export requirements. Table 4.5 presents data on *Salmonella*-related requirements for the top 10 importers of U.S. broilers.[16] Russia and Estonia currently require *Salmonella* testing of certain imports and have low- or zero-tolerance policies, and Japan explicitly reserves the right to test for *Salmonella*.

Although only 3 countries covered in table 4.5 have *Salmonella*-specific requirements, other countries have regulations that indirectly deal with *Salmonella* and other foodborne pathogens. For example, some countries reserve the right to subject imports to general microbial testing, which would likely include testing for *Salmonella* and which would lead to the rejection of shipments that test positive for *Salmonella*. Chile was also included in the table as it provides an example of a different standard. Chile effectively imposes a zero-tolerance regulation for imports by declaring that fresh/frozen (raw) poultry is not eligible for importation; only fully cooked or canned poultry products are eligible (FAS, 2002). As proper cooking and canning kills *Salmonella*, this regulation means that the allowed imports are *Salmonella*-free. Bilateral consultations between the United States and Chile on *Salmonella* began as early as 1992. Historically, the United States has been concerned that Chile holds poultry imports and its domestic poultry to different *Salmonella* standards and that Chile has not substantiated the claim that *Salmonella* is more prevalent in imports from the United States than in Chilean poultry stocks (WTO, 2001).

In addition to Chile, four other countries (the Czech Republic, El Salvador, Honduras, and Slovakia) applied zero-tolerance standards for *Salmonella* in 1996, according to the WTO (2001). Like the U.S. response to Chile, the U.S. response to these four countries in October 1996 was that this standard was discriminatory because these countries did not have eradication and surveillance systems capable of reaching this high standard in domestic products, yet expected imports to follow this standard (WTO, 2001). Negotiations between the United States and these five countries on *Salmonella* standards continues.

There are several examples where U.S. poultry exports to Russia, the Ukraine, and other countries have been periodically interrupted when *Salmonella* contamination was found in shipments or suspected in imported meat or poultry products. In 1995, Russia was the leading importer of U.S. poultry meat, importing about 1.6 billion pounds of broiler and turkey meat valued at almost $600 million (not including indirect shipments through Baltic countries). Requests to certify the absence of *Salmonella* was a key issue of contention in 1995-96, when Russia threatened to embargo U.S. poultry meat exports. The Russian position on this threatened embargo was based on the claim that U.S. poultry products did not meet the health requirements set forth in a 1993 bilateral agreement regarding *Salmonella* standards. This claim was partly based on some legitimate concerns (e.g., a spoiled shipment of frozen U.S. poultry meat in June 1995). The threat of this ban prompted Tyson Foods Inc., the largest U.S. poultry producer, to announce plans to scale back pro-

[15] HACCP systems identify potential sources of pathogen contamination and establish procedures to prevent contamination and their transmission to humans through food. HACCP plans generally follow seven steps: conduct a hazard analysis; identify critical control points (CCP) for physical, biological, and chemical hazards; establish critical limits for preventive measures associated with each CCP; establish CCP monitoring requirements; determine and perform corrective actions; establish recordkeeping systems; and conduct verification procedures.

[16] Note that the U.S. imports very little poultry (table 4.1). The top poultry exporters are the U.S. (2,825,000 mt) Brazil (947,000 mt), Hong Kong (791,000 mt), France (416,000 mt), China (410,000 mt), and Thailand (323,000 mt) (FAS, March 2001). Note that countries may also be transhipment points for international trade (e.g., Hong Kong).

Table 4.5—Import requirements for poultry and quantities for the top 10 importers of U.S. broilers and for Chile

Importing country	Products eligible for import from the U.S.[1]	*Salmonella*-specific regulations/requirements[1]	Imports from US[2]
			Mil. pounds
Hong Kong	Fresh/frozen poultry and poultry products	Products may be subjected to laboratory examination for microbiological contamination and positive-testing shipments refused entry	1,291
Russia	Poultry and poultry products, excluding consumer-size packages of ground poultry, mechanically deboned poultry, and giblets	Negative *Salmonella* test results must be presented to FSIS veterinarian before export certification can be issued; consignments are ineligible if there are more than 1 (in 5 minimum) positive samples	986
Latvia	Poultry and poultry products, except mechanically separated and ground products; must be certified as not having been fed material originating from sheep	No separate *Salmonella*-specific requirements	500
Mexico	Fresh/frozen poultry and poultry products	No separate *Salmonella*-specific requirements	325
Japan	All domestic poultry, except duckling giblets, coloring agents in raw products, and poultry and poultry products from or passing through Pennsylvania	Japanese Ministry of Health reserves the right to test shipments of ground and mechanically deboned poultry for *Salmonella* and to reject positive-testing shipments	224
China	Fresh/frozen poultry products	No separate *Salmonella*-specific requirements	163
Canada	Federally inspected poultry and poultry products, except carcasses, parts, or mechanically separated poultry parts containing kidneys or sex organs	No separate *Salmonella*-specific requirements	157
Korea	Poultry and poultry products, except those imported into the U.S. from a third country	No separate *Salmonella*-specific requirements	131
Estonia	Poultry and poultry products	Mechanically deboned poultry product is tested for *Salmonella* at the port of entry; positive-testing shipments will be denied entry	247
Poland	Fresh/frozen poultry and poultry products and poultry trimmings, except frozen ground and mechanically deboned poultry	No separate *Salmonella*-specific requirements	98
Chile	Fully cooked and canned products	Cooking and canning requirement effectively means no *Salmonella*	--[3]

[1] FSIS, 2002.
[2] Economic Research Service, 2002. Average for 1999-2000.
[3] Not listed separately.

duction by over 5 percent (Associated Press, March 18, 1996). High-level negotiations ensued and trade was resumed.

Later in 2002, there was a short-lived Russian ban on U.S. poultry meat exports as Russia cited *Salmonella* and antibiotic use in poultry production. Partly as a result of this 2002 ban, poultry exports from the United States for 2002 dropped by 13 percent, and U.S. poultry exports to Russia dropped by 35 percent. Orden et al. (2002, p. 162), reporting results from a spatial equilibrium model, suggested that an imposition of sanitary restrictions by Russia on U.S. imports of low-value poultry products would be mitigated because there are sufficient arbitrage possibilities in world markets—as long as the restriction is not imposed on other exporters. However, the restriction was imposed on countries other than the United States (e.g., the Netherlands) and there were real impacts on prices for U.S. poultry exporters.

Similarly, poultry trade between other pairs of countries has been interrupted by real or perceived *Salmonella* contamination. For example, in September 1999, McDonald's temporarily suspended poultry sales in Lithuania after Lithuania banned a Polish company's delivery of 1.5 tons of cooked products contaminated with *Salmonella* (Reuters, Sept. 2, 1999).

The United States also has restrictions on poultry meat imports, largely to keep certain animal and/or human diseases out of the country. For example, imports are restricted from regions where Exotic Newcastle Disease is known to exist. In fact, currently only four countries (Canada, Great Britain, France, and Israel) are permitted to export fresh, frozen, and chilled poultry to the United States, although some plants in northern Mexico may also re-export poultry meat of U.S. origin back to the United States after minimal processing (see chapter 3). As a major poultry producer, however, the United States does not and would not be likely to import significant quantities of poultry in the absence of these restrictions (table 4.1).

Responses to breaches in countries' *Salmonella* standards have taken the form of temporary bans with corrective action or refusals of specific contaminated shipments of products. Vertical integration in the U.S. poultry industry protects producers from some risks, but the importance of poultry exports combined with the possibility of new or extensive *Salmonella*-related embargoes, bans, or new zero- or low-tolerance standards poses financial risks for many integrated producers.[17]

Conclusions From the *Salmonella* Case Study

Many countries have trade restrictions for *Salmonella* and these restrictions vary widely by type (specific products or processing methods), extent (inspections of slaughter facilities, production practices), and duration. Some countries have zero- or low-tolerance standards for *Salmonella* in imported poultry while others reserve the right to test for *Salmonella* or permit imports of cooked or canned products only, which in practice implies a zero-tolerance standard for *Salmonella*. These standards affect international trade in livestock products and could also affect the choice of production technologies used in exporting countries. For example, an exporter may choose not to trade with a country having a zero-tolerance standard if the net gains to trade do not cover the costs of meeting the standard. Despite the permanent standards for *Salmonella*, trade interruptions due to *Salmonella* are mostly shortlived bans against specific products or rejections of specific contaminated shipments. Some countries' import standards are inconsistent with their domestic standards; to avoid running afoul of WTO regulations, such differences need to be based on science or legitimate differences in risk preferences, otherwise they might face allegations that they are being used as trade barriers. Further research is needed to determine whether world poultry trade would be higher if countries were to harmonize around lower standards or vice versa. Also, further research is needed to increase our understanding of the size of food safety diversions relative to total world poultry trade.

Case Study 3: Concerns about the Potential Trade Impacts from Antibiotic-Resistant *Salmonella*

Another dimension of the potential trade impacts from pathogen-food safety issues, and the focus of this third

[17] The U.S. poultry industry is very different from the U.S. beef industry. Although both poultry and beef production are moving toward fewer and larger producers, poultry operations are currently more integrated, while beef operations remain dispersed among a greater number of smaller independent operations. One cost-reducing benefit of low-level antimicrobial drug feeding is the ability to have greater numbers of livestock at one facility.

case study, is the capacity of many foodborne pathogens, including *Salmonella*, to develop resistance to antimicrobial drugs. This case study discusses three elements of this issue and trade implications: (1) the increasing drug resistance observed in *Salmonella*, (2) the controversy over the extent to which antibiotic drug use in livestock production contributes to the development of drug-resistant pathogens, and (3) the potential for food contamination with drug residues.

Increasing Drug Resistance

Drug use in livestock is implicated in antimicrobial resistance in humans because many antimicrobial drugs used for livestock are the same as or similar to drugs used for humans. Some pathogens can pass from livestock to humans, either directly through contact (Feinman, 1979; Fey et al., 2000; Holmberg et al., 1984) or through food products that are improperly processed, handled, or prepared. Some foodborne illnesses in humans caused by resistant pathogens have been traced to livestock products (Gashe and Mpuchane, 2000; USDA, 1997; White et al., 2001) and have been linked to live animals on farms (Feinman, 1979; Holmberg et al., 1984; Molbak et al., 1999).

In livestock trade, the importing country not only sets product standards (e.g., the zero tolerances for *Salmonella*), they may also set process standards (e.g., the EU hormone ban) (FAS, 2003). They may also require government verification of the standard which can lead to a virtual ban in two ways—the cost of verification is prohibitive (e.g., hormones), or the government is unable to provide the desired verification and certification (FAS, 2003). While not now directly a trade issue, drug use by livestock could become more of an international trade issue if prohibitions against domestic production technologies in importing countries were expanded to more fully cover imports. For example, Russia and the Ukraine both periodically threaten or impose temporary prohibitions on imports of U.S. poultry products based on drugs or chemicals used in production (e.g., Reuters, Jan. 23, 2002). These prohibitions could mean that exporters who use the implicated antibiotics in animal production would have to sell their products to other countries (perhaps at lower prices), incur higher transportation costs, or destroy contaminated shipments altogether. Data are not readily available on the magnitude of imports diverted because of this issue. To date, no country has proposed formal prohibitions against *therapeutic* uses of livestock drugs (i.e., antibiotic use for treatment of disease), which would have animal welfare implications.

S. Typhimurium (hereafter referred to as Typhimurium) is the type of *Salmonella* most often mentioned in discussions about antibiotic resistance from livestock drug use. Typhimurium strains have caused numerous human illnesses and deaths worldwide. Typhimurium DT-104 is particularly troublesome, with a hospitalization rate double that of other foodborne *Salmonella* infections and a fatality rate 10 times higher (WHO, 1997).

Human illness from DT-104 was first recognized in England and Wales in the 1960s, but resistant DT-104 has been known only since the 1980s (Threlfall, 2000). The first resistant isolates were taken from gulls and exotic birds. The resistance was not isolated from humans until 1989, and was then isolated from cattle over the next 5 years (Threlfall, 2000). It has also been isolated from poultry, swine, other domestic animals, and wild animals (USDA, 1997). DT-104 has been detected mainly in industrialized countries with more concentrated livestock production technologies (e.g., Austria, Canada, Denmark, France, Germany, UK, and the United States) (USDA, 1997).

About 95 percent of DT-104 strains are resistant to ampicillin, chloramphenicol, streptomycin, sulfonamides, and tetracycline (GAO, 1999), antibiotics commonly used to treat human illnesses. Since 1996, UK scientists have also reported resistance to fluoroquinolones (GAO, 1999). This resistance to fluoroquinolones occurs in about 14 percent of DT-104 strains in the UK (GAO, 1999), but is currently rare in the United States (Marano et al., 1999). In the United States alone, there are an estimated 68,000 to 340,000 human illnesses from S. Typhimurium each year with resistance to five antibiotics, and most of these illnesses were probably due to DT-104 (Glynn et al., 1998).

Pathogens affecting livestock and pathogens affecting humans are often of different types or are often present in differing concentrations. For example, while many of the same *Salmonella* serotypes are found in both humans and livestock, the 5 most common types of *Salmonella* in cattle (of 26 serotypes identified) were different from the 5 most common human types identified by the U.S. Centers for Disease Control and Prevention as associated with human illnesses (USDA, 1995). This difference in primary serotypes emphasizes the fact that we do not have a thorough understanding of the epidemiological link between humans and animals.

While some pathogens appear to be widespread in terms of infected U.S. livestock operations and markets, their prevalence in livestock populations appears much lower. The share of animals that tested positive for *Salmonella*, *Escherichia coli*, or other selected bacteria has ranged from 1 to 5 percent, while the number of livestock operations or markets that had at least one positive test has ranged from 10 to 67 percent (USDA, 1995, 1996b, 1998, 2000). The prevalence of drug resistance in bacteria from these samples, however, is not known. While some samples likely contained resistant strains of bacteria, it is unlikely that all samples contained resistant bacteria.

Livestock Drug Controversy

Some countries (e.g., EU member countries) prohibit the low-level (*subtherapeutic*) use of certain antimicrobial drugs as growth promotants in livestock production. Others have proposed such prohibitions based on policymakers' perception that enough evidence links livestock drug use and human antibiotic effectiveness in treating foodborne illnesses. In the United States, several bills have been introduced to prohibit antibiotics from at least some uses in animal agriculture (e.g., H.R. 3266 on Nov. 9, 1999, H.R. 3804 on Feb. 27, 2002, S. 2508 on May 13, 2002, and S.1460 and H.R. 2932, both on July 25, 2003). In June 2000, the WHO adopted a statement of principles proposing that use of antimicrobial livestock drugs to promote growth be terminated. In June 2001, the EU prohibited all but four antimicrobial drugs used as growth promotants in livestock production (Mathews et al., 2001). The four remaining drugs will be phased out by 2006 (European Council, 2002).

Livestock Drug Residues

A related issue concerning antibiotic drug use in livestock pertains to antibiotic drug residues that are considered unsafe yet remain in some internationally traded animal products (see box 4.4). Some importing countries have refused entry to shipments testing positive for these drug residues. Others have invoked temporary bans on shipments from specified countries. For example, the EU's veterinary committee recommended that the EU suspend imports of some meats and seafood from China because of antimicrobial drug residues in farm-raised shrimp and prawns (Reuters, 1/28/02).[18]

The EU has prohibited the subtherapeutic use of some antimicrobial drugs in livestock production and other countries have proposed such prohibitions because of their concerns about possible effects on resistance in foodborne pathogens. These restrictions could extend to antimicrobial drug use in livestock production by exporting countries and could also force changes in production technologies. A concern of the United States is the science base for these and other food regulations. Countries vary in what they accept as sound science, which is particularly important in risk assessments.

Conclusion

Increased urbanization, increasing populations, and rising incomes have increased per capita demand for meat, milk, and eggs worldwide. The increased demand for high-quality protein to improve children's growth, cognitive development, and health has also contributed to increased global demand for meat and poultry. Concerns about food safety hazards in meat and poultry have motivated public and private efforts to ensure safer food and to protect markets, both domestically and internationally. These food safety hazards are particularly worrisome if they make a large number of people ill worldwide (e.g., *Salmonella*) or if they are particularly virulent (e.g., BSE).

Public sector responses have ranged from position statements (WHO, FAO, and OIE) to regulations affecting imports and exports, such as minimum standards for pathogen, chemical, and residue contaminants in imported food products. The regulations related to these standards range from rejection of specific shipments (e.g., for *Salmonella*) to longer term bans against all potentially contaminated products (e.g., against imports of live cattle from the UK because of BSE concerns). Food safety standards and regulations vary by country but are evolving in response to the WTO principles, emerging food safety incidents and risks, and new technology.

Impacts and regulations often extend beyond the sectors directly affected by a food safety issue. For example, BSE has affected the rendering industry and feed,

[18] The United States has embargoed shipments of aquacultural products contaminated with chloramphenicol.

Box 4.4—Antibiotic Residues

Drugs administered to livestock can affect human health and food safety through drug residues in food products. Small amounts of such residues have been deemed safe for human consumption worldwide by the Food and Agriculture Organization (FAO) and the Food and Drug Administration (FDA). The FDA, for example, established 1.5 milligrams per person per day as the acceptable daily intake (ADI) of noncarcinogens. For antimicrobial drugs, this is a level that should produce no effects on the human intestinal bacteria. Other antimicrobial drugs have not been approved for use in livestock production or have been outlawed.

Residues from some antibiotics are considered unsafe at any level. FDA has not established ADIs for these drugs. For example, chloramphenicol is still used occasionally to treat diseases in aquacultural operations in China, India, Indonesia, Malaysia, Thailand, and Vietnam, all of which are major exporters of shrimp. Its use has declined in these areas as information reaches farmers about its toxicity—it has caused leukemia and can cause genetic damage, possibly leading to cancer. The chemical has, however, found its way into livestock feeds and livestock products in Europe.

Developing new drugs is expensive. Drug manufacturers and sellers must abide by increasingly stringent and time-consuming regulations and legislation when developing new drugs for use on either humans or animals. The Animal Health Institute estimates that only 1 in 20,000 discovered chemicals becomes available for farm use. Approval of a new drug can take a decade or longer.

Major legislation affecting animal drug use and residue levels since 1989:

Nutrition, Labeling, and Education Act of 1990—Pre-empts State requirements about food standards, nutrition labeling, and health claims.

Animal Medicinal Drug Use Clarification Act of 1994—Allows licensed veterinarians to prescribe human drugs for use in animals under certain conditions.

Animal Drug Availability Act of 1996—Adds flexibility to animal drug approval process.

Food and Drug Administration Modernization Act of 1997—Regulates advertising of unapproved uses of approved drugs.

gelatin, cosmetic, pharmaceutical, and medical sectors. In many countries, new rules and regulations for feedstuffs have been put in place to allay public sector concerns over BSE and food safety threats such as vCJD. But new regulations to solve one food safety problem can create new trade challenges. For example, higher EU standards for gelatin are currently blocking U.S. gelatin exports to the EU even though BSE has never been identified in the United States. Countries worldwide, with and without endemic BSE, are affected by the crisis both in terms of market access for exports and new, targeted restrictions for imports.

International food safety standards concerning *Salmonella* and poultry vary by type (specific products or processing), extent (inspections of slaughter facilities, production practices), and duration. These bans usually pertain to contaminated shipments, but governments may also impose temporary bans against specific products from specific producers or countries. Meanwhile, production and process standards can extend to drugs administered to livestock even when residues have not been identified as a problem (e.g., threatened Russian ban against poultry) and in part, because of concerns that some pathogens, such as *Salmonella*, can develop resistance to drugs meant to kill them.

This variety in standards is one example of national sovereignty where each WTO member has the right to determine its own level of SPS protection. Part of the diversity in standards may reflect differences in the science base among countries. Two challenges related to *Salmonella* facing international bodies are how to handle "zero-tolerance" standards when science suggests that zero risk is infeasible, and how to ensure that any differences between standards for domestic and imported products are based on science or legitimate differences in risk and are not simply trade barriers in disguise.

In addition to public sector approaches, private approaches to reduce food safety risks are becoming more widespread and stringent (Caswell and Henson, 1997) and are helping firms improve their international competitive positions in cases where the products are perceived to be safer. Private sector approaches for meat and poultry include self-regulation, vertical integration (to ensure quality/safety of inputs and traceability, for example), voluntary or mandatory HACCP systems, and third-party certification such as the International Organization for Standardization. For example, in the United States, McDonald's has imposed antibiotic restrictions on its livestock suppliers (Lipsky, 2003), even though the U.S. government does not believe this is necessary (FAS, 2003). Effective implementation of such private sector approaches is key to enhancing food safety, in tandem with public approaches (e.g., country-of-origin labeling). Some of these private responses may have supply implications for exporting countries.

Many producer groups have voluntarily developed guidelines for their members aimed at enhancing the safety of their commodities.[19] These "Quality Assurance Programs" are designed to ensure wholesome livestock products. They include elements aimed at reducing pathogens and at properly using pharmaceuticals (Committee on Drug Use in Food Animals, 1998). Other private organizations that have adopted guidelines for antimicrobial drug use include the American Veterinary Medical Association, American Association of Bovine Practitioners, and American Association of Swine Practitioners (USDA, 1999). Several U.S. producers have also reduced or plan to reduce their use of certain antibiotics to ease consumers' fears (Burros, 2002; Kilman, 2002). For example, several U.S. poultry producers have begun withdrawing their use of the fluoroquinolone drug Baytril.

[19] The Committee on Drug Use in Food Animals (1998) provides examples of these producer groups, which include the National Pork Producers Council, National Cattlemen's Beef Association, National Milk Producers Federation, American Sheep Industry Association, American Veal Association, National Broiler Council, National Turkey Federation, United Egg Producers, Catfish Farmers of America, National Aquaculture Association, and U.S. Trout Farmers Association.

Some ongoing meat and poultry disputes have highlighted the difficulty in separating actions designed to ensure food safety of imported food products from actions to erect trade barriers using SPS standards as the justification. For example, Russia restricted or threatened to restrict poultry imports several times over the past decade, justified in part by its zero tolerance for *Salmonella* contamination and the use of certain antibiotics in U.S. poultry production that are not registered in Russia. Even after the United States made changes to meet Russian demands, Russia imposed import tariffs and quotas in 2003. These restrictions and tariffs are crucial in terms of trade because Russia is the world's largest importer of broilers (FAS, 3/11/02). Ukraine continues to ban U.S. poultry even after a protocol was negotiated that met its concerns (FAS, 2003).

The twin goals of ensuring food safety and protecting trade can be enhanced through transparent and immediate public responses to food safety crises, as well as up-to-date prevention and monitoring efforts. Transparent and immediate public response to food safety crises is necessary to protect consumer confidence in the food supply and in the government (Pickelsimer and Wahl, 2002). For example, consumer confidence in the UK declined in 1996 when the British government reversed its previous position that BSE was not related to human illnesses. Given emerging food safety issues and the spread of known problems to new regions (e.g., spread of BSE to Japan and Canada), it is increasingly important for policymakers to anticipate foodborne hazards and, if these hazards materialize, to launch control measures that mitigate their effects on human health, animal health, and international trade. Ideally, actions should be commensurate with the food safety risks to human and animal health.

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