Commodity Trade Analysis in a General Equilibrium Framework
BSE Restrictions on Beef Imports from the United States and Canada

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Abstract

This paper estimates the economic impacts of BSE-related restrictions imposed on beef imports from the United States and Canada in 2004. The analysis is based on a simulation framework which consists of a partial equilibrium (PE) model and a general equilibrium (GE) model. The PE model focuses on bilateral trade in beef products at the HS six-digit level. The GE model is an economy-wide computable general equilibrium model of bilateral trade specified at an aggregate product level. It is estimated that the long-term effects of the 2004 BSE bans were a $3.1 billion, or 84 percent decline in annual U.S. beef exports; a 6 percent decline in the supply of U.S. beef cattle; a $1.3 billion, or 9 percent decline in beef cattle sales revenue; and a $2.7 billion, or 7 percent decline in beef packing sales revenue.

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1. Introduction

On December 24, 2003 the U.S. Secretary of Agriculture announced that a cow slaughtered two weeks earlier near Yakima, Washington had tested positive for bovine spongiform encephalopathy (BSE) or mad cow disease, the first such case in the United States (Wald and Lichtblau, 2003). Shortly after the announcement, Japan, South Korea, and Mexico, the three largest importers of U.S. beef, announced import bans. Other countries that announced bans included Russia, Thailand, Malaysia, Chile, Australia, Singapore, Taiwan, and Hong Kong. Canada restricted imports of many U.S. beef products although the import ban was far from total.

Beginning in 2004, several countries resumed imports from the United States. Yet certain markets, most notably Japan and Korea continued their restrictions, such that the value of U.S. beef exports in 2007 was only about two-thirds of the 2003 level.

This paper estimates the economic impacts of BSE-related restrictions imposed by certain countries on beef imports from the United States and Canada in 2004. The analysis is based on simulations with partial equilibrium and general equilibrium models. The long-term effects of the 2004 BSE bans were a $3.1 billion, or 84 percent decline in annual U.S. beef exports; a 6 percent decline in the supply of U.S. beef cattle; a $1.3 billion, or 9 percent decline in beef cattle sales revenue; and a $2.7 billion, or 7 percent decline in beef packing sales revenue.[1]

2. The Simulation Framework

This analysis is based on simulations with a modeling framework which consists of a partial equilibrium (PE) model and a general equilibrium (GE) model. The PE model focuses on bilateral trade in beef products, specified at the Harmonized System (HS) six-digit level, between

[1] For an in depth analysis of the various measures affecting U.S. beef exports and their economic effects see U.S. ITC, 2008.

the United States and other major markets. Cattle and beef production and consumption are specified at a more aggregate level.

In the simulation of the BSE-related restrictions, the PE model finds market-clearing prices for each of the beef products. Several of the variables considered in the analysis, however, are outside the scope of the PE model. These variables include livestock feed prices; other input costs for beef producers; other product prices for demanders of beef products; and household income. These variables influence the estimated effects for beef trade, production and consumption. In this work, a GE model provides estimates of these effects.

The advantage of linking a PE model to a GE model is that the PE model accounts for differences in bilateral trade policies at the HS six-digit level while the GE model provides for linkages with the rest of the economy, especially the rest of agriculture, both within the United States and other economies. The appendix discusses in detail the PE model and simulations.

Studies of livestock sector issues apply one of two approaches. One approach is that of dynamic, short-run analysis. Under this approach the analysis considers year-to-year changes or even quarter-to-quarter changes (e.g., Paarlberg *et al.*, 2008). The other approach is that of long-term analysis where the analysis considers changes between the market equilibrium before the policy change and the equilibrium after the policy change when all adjustments have taken place (e.g., Devadoss *et al.*, 2006, and Wigle *et al.*, 2007). This work follows the latter approach.

3. Aggregating Trade Policy Measures

Linking a PE model to a GE model not only provides a detailed analysis of the BSE restrictions within a GE framework, but also provides an improved method of aggregating trade policies. Applied GE models are aggregate in their sectoral and product specification. At a minimum, their product specification converts individual tariff lines into aggregates that conform to the higher-level statistics available for production and consumption.

The most common method of aggregating trade policies is based on import value weights. An important advantage of import value weights is that the necessary statistics are accessible at the HS six-digit level. A shortcoming of the method is that if a tariff rate increases, import demand would decrease, and the weight of that tariff would decline thereby reducing the importance of that tariff in the aggregate tariff.

Several authors have studied the implications of aggregating trade policies in GE models. Bach, Martin, and Stevens found that their estimate of economic welfare from China's trade reforms in the context of WTO accession was doubled if appropriate tariff aggregators were used to account for tariff dispersion. Bach and Martin subsequently defined ways in which a detailed set of tariffs may be aggregated consistently to measure tariffs at the sectoral level.

The Bach-Martin aggregation procedure was used by Martin, van der Mensbrugghe, and Manole to analyze European Union (EU) tariff reform. Martin *et al*. estimated that global economic benefits from EU agricultural trade reform increased by over 150 percent under consistent tariff aggregation. Martin *et al.* concluded that inappropriate tariff aggregation may cause substantial underestimation of global economic gains from trade reform. Subsequently, Manole and Martin refined the tariff aggregators proposed by Bach and Martin and found that economic welfare gains from trade liberalization are severely underestimated when using the traditional tariff aggregator.

Grant, Hertel, and Rutherford developed a solution to the problem of aggregating trade policies that is both tractable and can be readily implemented in applied analysis. Grant *et al.* developed a PE model of dairy products that tracks trade policies at the HS six-digit tariff line level. The PE model was embedded in a standard GE model of the global economy to provide a comprehensive analysis of trade policy reform.[2]

[2] Other works applying a PE-GE approach are Narayanan, Hertel, and Horridge, 2008 and Jansson, Kuiper, Banse, Heckelei, and Adenaeuer, 2008.

This work extends the Grant *et al.* approach by expanding the scope of the PE model to cover not only trade but also supply and demand of beef products at the farm level, at the processing level, and at the final demand level.

A PE-GE approach is also useful in this work because of the nature of the trade policies analyzed. The standard approach of simulating the ad valorem tariff equivalents of quantitative import restrictions at an aggregate product level is difficult to implement here because different quantitative restrictions were placed on specific beef products. The PE model, however, allows the simulation of the quantitative restrictions at the HS 6-digit product level and the estimation of ad valorem tariff equivalents at an aggregate product level.

4. Linking the PE model to the GE model

The simulation performed with the PE-GE framework consists of three steps. First, a PE simulation provides estimates of the effects of restricting the quantity of beef imports from the United States and Canada at the HS six-digit level. Among the outcomes of the PE simulation are estimates of the ad valorem tariff equivalents of the quantitative restrictions. Second, the effects of the estimated tariff equivalents are simulated with the GE model to obtain estimates of the GE effects. Third, the effects of the quantitative restrictions are simulated again with a PE simulation that incorporates the estimates of selected GE effects.[3] This second-round PE simulation provides updated estimates of the effects on U.S. beef trade, production, and consumption.

The PE model and simulations are discussed in detail in the appendix. The GE model is the Global Trade Analysis Project (GTAP) model, an economy-wide computable general equilibrium model of world trade specified at an aggregate product level (Hertel, 1997).[4]

[3] The appendix discusses the GE effects that are included in the second-round PE simulation.
[4] This analysis is based on release 6.1 of the GTAP database (Dimaranan and McDougall, 2005).

5. Simulated Effects of BSE Restrictions

Table 1 shows estimated effects on the volume of U.S. exports for the 12 HS six-digit beef products.[5] U.S. exports are estimated to have declined by 59–95 percent in 2004. As a result of these bans, U.S. export prices are estimated to have declined substantially for most beef products. U.S. export prices of HS 1602.50 (prepared or preserved beef) are estimated to have risen because U.S. exports of this product declined, even though the BSE bans for this product was less restrictive than those for other beef products.

Table 1 also shows declines in U.S. exports, by value for 2004. Total U.S. export revenue declined by $3.1 billion, or 84.1 percent. Three beef product categories (HS 0201.30 fresh/chilled boneless, HS 0202.30 frozen boneless, and HS 0202.20 frozen bone-in) accounted for more than 80 percent of the reduction in U.S. export revenue.

Table 2 shows estimated effects on the volume of exports of four broad categories of beef products—offal, carcasses, bone-in, and boneless—from the United States and other countries. The most affected categories of U.S exports are estimated to have been bone-in beef products (exports declined by 94 percent) and beef carcasses (exports declined by 84 percent).

As U.S. and Canadian exports decreased, exports from Australia and New Zealand increased substantially (table 2). Mexican imports also increased, but from a small base. Korean exports of beef meat products decreased because their prices in the world market increased less than their prices in the domestic market.

Table 3 shows estimated effects on U.S. exports of all beef products, by country of destination. U.S. exports to Korea and Japan were affected the most by the BSE-related measures because the BSE-related measures of these two countries were quite restrictive and because the United States exports large quantities of beef to these two countries.

[5] Appendix table 1 lists the HS six-digit beef products which are identified in the PE model and the aggregate product categories in the GE model. Appendix table 1 also lists the economies identified in this paper.

Tables 4 and 5 show estimated effects on the volumes and prices of beef meat trade, domestic production, and demand. U.S. exports of beef meat are estimated to have declined by 76.8 percent in volume, while their prices declined by 30.1 percent. The U.S. supply of beef meat to the domestic and foreign markets is estimated to have declined by 6 percent while the producer price declined by 0.8 percent. The U.S. producer price of all beef products (i.e., meat and offal) is estimated to have declined by 1.42 percent. The price of beef offal is estimated to have declined by 16.7 percent.

BSE-related restrictions on exports of U.S. and Canadian beef reduced the supply of beef available in the world market; thus, the prices of beef imported in the United States are estimated to have increased by 16 percent (table 5) which affected demand and supply in the United States. U.S. demand for imported beef declined and as a result, even though domestic demand for U.S. beef increased, overall U.S. demand for beef is estimated to have declined by 1.5 percent. On the supply side, the increased price of imported beef in the U.S. market prevented the producer price for U.S. beef from declining by more than 1.42 percent.

It is estimated that the BSE-related measures in effect in 2004 caused the long-run annual sales revenue of the U.S. beef packing industry to decline by $2.7 billion, or 7.4 percent. Most of the lost sales revenue was in beef meat.

Table 4 shows that Australia is estimated to have filled most of the void left by restrictions on imports of U.S. and Canadian beef. Australian supply of beef meat is estimated to have increased by 42 percent. To induce this increase in Australian supply, however, Australian beef export prices are estimated to have increased by 28.1 percent and producer prices by 22.8 percent (table 5).

Table 6 shows estimated effects for the beef cattle industry. The producer price for U.S. beef cattle is estimated to decline by 3.4 percent because of the BSE-related restrictions. As a

result of lower prices, the supply of U.S. beef cattle declined by 5.6 percent. The U.S. beef cattle industry is estimated to lose $1.3 billion in annual revenue or about 9 percent.[6]

Table 6 shows that despite large beef exports from Brazil and Argentina, beef cattle production in these two countries does not expand significantly because most of the countries that banned U.S. and Canadian beef were not importing beef from Brazil and Argentina due to foot and mouth disease restrictions.

6. Summary and Conclusions

This paper estimated the economic impacts of BSE-related restrictions imposed on beef imports from the United States and Canada in 2004. The analysis was based on a simulation framework which consists of a partial equilibrium (PE) model and a general equilibrium (GE) model.

The long-term effects of the 2004 BSE bans were a 6 percent decline in the supply of U.S. beef cattle; a $1.3 billion, or 9 percent decline in beef cattle sales revenue; and a $2.7 billion, or 7 percent decline in beef packing sales revenue.

Linking a PE model to an off-the-shelf GE model for analyses of disaggregate trade policies provides a practical method which couples the richness afforded by the PE model with the economy-wide adjustments provided by the GE model.

[6] The decline in the U.S. price of beef products (1.42 percent) is much larger than the decline in the U.S. price of beef cattle because, as suggested by the GE simulation, the U.S. prices of the processing inputs employed in beef production are declining by much less than the price of beef cattle.

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Table 1. Effects of BSE restrictions: Change in U.S. exports

HS heading	Product	Volume of exports	Price of exports	Export revenue	Export revenue
		Percent	*Percent*	*Million $*	*Percent*
0201.10	Fresh/chilled carcass	-86.5	-57.8	-10.1	-94.3
0201.20	Fresh/chilled bone-in	-91.2	-81.6	-85.8	-98.3
0201.30	Fresh/chilled boneless	-72.8	-16.9	-1,266.3	-77.4
0202.10	Frozen carcass	-81.0	-32.9	-6.6	-87.2
0202.20	Frozen bone-in	-94.5	-90.1	-382.9	-99.4
0202.30	Frozen boneless	-85.1	-62.8	-934.0	-94.4
0206.10	Fresh/chilled edible offal	-71.2	-21.1	-13.0	-77.2
0206.22	Frozen edible offal, tongue	-79.5	-49.8	-96.4	-89.7
0206.29	Frozen edible offal, liver	-71.3	-21.2	-59.6	-77.3
0210.20	Frozen edible offal, other	-78.4	-46.2	-220.5	-88.3
0210.20	Salted, in brine, or dried	-79.8	-47.1	-9.4	-89.3
1602.50	Prepared or preserved beef	-59.1	117.4	-11.8	-11.0
	Total			-3,096.2	-84.1

Source: Authors' calculations with simulation framework discussed in this paper.

Table 2. Effects of BSE restrictions: Percent change in beef export volumes for four categories of beef products

Exporting country	Bone-in	Boneless	Carcasses	Offal
Argentina	7.8	4.0	54.0	9.3
Australia	110.8	66.7	160.7	59.6
Brazil	10.1	5.0	53.0	10.9
Canada	-58.6	-6.2	-3.4	-17.9
China	24.3	35.0	44.7	5.0
EU-15	1.2	1.5	0.9	3.0
EU-12	2.7	3.7	2.0	20.8
Indonesia	6.8	21.1	8.0	3.8
Japan	-8.9	-4.3	13.5	80.1
Korea	-49.3	-54.4	-44.9	51.0
Mexico	81.3	27.6	172.3	24.1
New Zealand	87.0	33.4	21.3	35.6
ROW	3.4	4.8	5.2	15.7
United States	-93.7	-76.5	-83.9	-76.9
Uruguay	3.4	11.2	48.7	12.4
Russia	6.0	0.9	-1.1	9.8

Source: Authors' calculations with simulation framework discussed in this paper.

Table 3. Effects of BSE restrictions: Change in value of U.S. beef exports, by country of destination (million dollars)

Country	Effect on U.S. beef exports
Argentina	0
Australia	0
Brazil	0
Canada	-204
China	-118
EU-15	-4
EU-12	4
Indonesia	16
Japan	-1,347
Korea	-821
Mexico	-368
New Zealand	0
ROW	-199
Uruguay	0
Russia	-55

Source: Authors' calculations with simulation framework discussed in this paper.

Table 4. Effects of BSE restrictions: Percent change in beef meat volumes

Country	Domestic production	Exports	Imports	Demand for domestic and imports
Argentina	0.7	4.4	14	0.1
Australia	42	68.3	-7.1	0.1
Brazil	0.9	5.2	-1.6	0.1
Canada	2.1	-9.9	-30.6	-1.9
China	2.2	46.2	-34.6	-0.3
EU-15	0.6	1.3	-0.7	-0.01
EU-12	0.2	3	-2.4	-0.1
Indonesia	-2.3	7.5	5.6	1.2
Japan	26.9	-4.5	-29	-11.2
Korea	26.8	-52.7	-27.7	-13.7
Mexico	3.4	37	-31.5	-1.6
New Zealand	29.9	36.5	-11.6	-0.2
ROW	1.2	4.9	-8.1	-0.1
United States	-6	-76.8	-18.8	-1.5
Uruguay	9	10.9	-49.1	0.7
Russia	1.3	-0.2	3.8	3.2

Source: Authors' calculations with simulation framework discussed in this paper.

Table 5. Effects of BSE restrictions: Percent change in beef meat prices

Country	Producer price	Export price	Price of imports	Aggregate demand price (domestic and imports)
Argentina	1.3	2.3	-7.3	1.1
Australia	22.8	28.1	18.1	12.5
Brazil	1.6	2.7	2.5	1.4
Canada	7.9	4.6	47.3	16.9
China	2.1	11.7	36.7	3.2
EU-15	0.7	0.9	1.3	0.9
EU-12	0.3	1	1.9	0.3
Indonesia	0.03	2.4	-5.2	-2.4
Japan	27.3	18.6	87.6	61.6
Korea	83.4	43.3	166.7	137
Mexico	5.8	13.5	38.9	9
New Zealand	19	20.5	22.3	12.8
ROW	1.7	2.6	8.3	2.4
United States	-0.8	-30.1	16	2
Uruguay	5.6	6	64	4.1
Russia	4.9	4.6	3.3	3.7

Source: Authors' calculations with simulation framework discussed in this paper.

Table 6. Effects of BSE restrictions: Changes for beef cattle industry

Country	Supply volume	Producer price	Producer revenue	Producer revenue
	Percent	*Percent*	*Million $*	*Percent*
Argentina	0.4	2.4	66	3
Australia	33.1	57.9	1,859	110
Brazil	0.5	3.1	184	4
Canada	0.4	14	229	14
China	1.5	4.4	160	6
EU-15	0.2	2	199	2
EU-12	0.03	0.9	7	1
Indonesia	-2.4	0.3	-1	-2
Japan	23.3	40.1	988	73
Korea	24.3	92.4	840	139
Mexico	1.1	15.2	352	16
New Zealand	25.6	35.3	473	70
ROW	0.5	4.5	384	5
United States	-5.6	-3.4	-1,325	-9
Uruguay	7.1	13.1	43	21
Russia	-0.4	11.8	11	11

Source: Authors' calculations with simulation framework discussed in this paper.

Appendix

Partial Equilibrium Model

A partial equilibrium-general equilibrium framework is used to perform the simulation in this work. A PE-GE simulation consists of three steps. First, a PE simulation provides estimates of the effects of restricting the quantity of beef imports from the United States and Canada at the HS six-digit level by certain countries. Among the outcomes of the PE simulation are estimates of the ad valorem tariff equivalents of the restrictions. Second, the effects of the estimated tariff equivalents are simulated with a GE model to obtain estimates of GE effects. Third, the effects of the quantitative restrictions are simulated again with a PE simulation that incorporates estimates of selected GE effects.

This appendix specifies the partial equilibrium model, the partial equilibrium simulations, and the PE-GE links. The GE model is the Global Trade Analysis Project (GTAP) model, an economy-wide computable general equilibrium model of world trade (Hertel, 1997, and Dimaranan and McDougal, 2005).

The Partial Equilibrium Model

Among the 14 meat products specified in the PE model, there are 12 HS six-digit beef products; the other two aggregate products are non-beef meat products and they are included in the PE model to align it to the GE model. The product and regional specifications of the PE and GE are presented in appendix table 1.

The PE model has a demand and a supply component. Appendix figure 1 shows the demand component of the PE model. In the top part of appendix figure 1, a representative economic agent in each region demands four aggregate goods: beef meat, beef offal, other meats, and other goods. The parameters that determine demands for these four commodities are own- and cross-price elasticities, ε_{ij}, and income elasticities, η_i. These elasticities are different from

region to region in the model.[7] Regional income and the price of "other goods" are exogenous variables in the PE model. The GE model estimates effects for these two variables, which are then passed to the PE model in a second-round simulation.

The middle part in appendix figure 1 shows that the representative demander in a region sources the three meats from domestic production and imports. The decision as to how much beef meat to import is a function of the import price relative to the price of domestic beef meat. A constant elasticity of substitution (CES) function is used to model this decision.[8] The constant elasticity of substitution, σ, is assigned the value 1.5.

Next, appendix figure 1 shows that total imports of a particular meat category are a modeled as a CES aggregate of their component products. Imported beef meat is a CES aggregate of eight HS six-digit products, while beef offal is a CES aggregate of four six-digit products. This part of the model implies that if the price of a particular imported beef-meat HS six-digit product increases, the representative demander would demand less of that imported product and more of the other imported beef-meat products. The constant elasticity of substitution takes the value of 2.5 for all three meat categories.

The bottom part of appendix figure 1 shows that the sourcing of imports of a particular six-digit beef meat product is modeled with a CES function and it implies that if, for example, the price of frozen boneless beef meat from Australia increases, the representative demander would demand less of the Australian product and more of frozen boneless beef meat from other regions. Similar sourcing equations apply to imports of beef offal and other meat products.

One of the assumptions of the modeling of demand in the PE model is that demanders differentiate the domestic product from the imported product. Demanders are also assumed to view imports of a particular product from a region as different from imports from all other

[7] Price and income elasticities for the meat commodities are from Stout and Abler, 2004. Price and income elasticities for the other goods category are from the GTAP model.
[8] A CES production function is characterized by a constant percentage change in factor (e.g. labor and capital) proportions due to a percentage change in the marginal rate of technical substitution (Arrow *et al.,* 1961).

regions. These two assumptions constitute the Armington assumption of product differentiation by country of origin (Armington, 1969).

Appendix figure 2 sketches the supply component of the PE model. The starting point is in the lower part of appendix figure 2, where supplies of cattle and other animals are modeled with a constant elasticity of transformation (CET) production possibilities frontier with an elasticity of transformation σ^T.[9] The scale of the farming operation is exogenous to the PE model. The GE model estimates effects for this variable, which are then passed to the PE model in a second-round simulation.

The two aggregate products "beef meat and offal" and "other meats" are produced by two processing sectors that demand meat animals and other inputs. Production in these two sectors is modeled with CES production functions that have an elasticity of substitution (σ) equal to 0.25. The beef processing sector supplies beef meat and beef offal in approximately fixed proportions. A CET function models these supplies, with a small elasticity of transformation ($\sigma^T = -0.10$).

In the next stage in the PE model, meat supplied to the domestic market is differentiated from meat exports. CET production possibilities frontiers are applied to beef meat, beef offal and other meats. The elasticity of transformation is assigned a large value ($\sigma^T = -4.0$), which implies that the degree of product differentiation between the product supplied to the domestic market and the product supplied to the export market is relatively small.

Regarding supplies to the domestic market, the model does not disaggregate beef meat and beef offal to six-digit HS level products. Exports of beef meat and beef offal, however, are modeled in more detail. For example, the model identifies exports of fresh offal (HS 0206.10) and three types of frozen offal: tongues (HS 0206.21), livers (HS 0206.22), and other offal (HS 0206.29). In particular two CET production possibilities frontiers model offal exports at the HS six-digit level. The first CET models export supply of fresh and frozen beef offal; the elasticity of

[9] A CET production production possibilities frontier is characterized by a constant percentage change in product-mix ration to changes in the marginal rate of transformation (Powell and Gruen, 1968).

transformation is -0.75. The second CET models export supplies of frozen tongues, livers, and other beef offal.

The Partial Equilibrium Simulation

Appendix table 2 lists the direct effects of the BSE-related restrictions on beef imports from the United States put in place by certain economies in 2004. The percent declines in the volume of beef imports from the United States in appendix table 2 were computed by comparing observed trade statistics for 2004 with trade statistics for 2003. These are the shocks that are simulated with the PE model. The absence of a bilateral trade effect in appendix table 2 indicates the lack of a BSE-related restriction on beef imports from the United States by a particular importer. For example, in 2004, Indonesia did not apply any restrictions on imports of U.S. frozen carcasses, HS 0202.10.

To perform the simulation, statistics describing beef markets in the absence of the BSE-related restrictions were developed for 2004. First, the GTAP data were updated from 2001 to 2003, and they were aligned with the HS six-digit trade statistics for 2003 in the PE model. Second, the GTAP data were updated from 2003 to 2004 via a simulation driven by observed changes in population, labor force, and GDP. This simulation established GTAP data for 2004 in the absence of the BSE-related restrictions on beef imports from the United States and Canada. Third, macro economic information and aggregate beef information from the GTAP data for 2004 drove a simulation with the PE model to establish PE data for 2004 in the absence of the BSE-related restrictions on beef imports from the United States and Canada. Thus the simulated effects in this report are with respect to beef markets in the absence of the BSE-related restrictions.

The Second-round PE Simulation

The following GE effects from the GTAP simulation are incorporated in the second-round PE simulation (GTAP model variables are given in parentheses): scale of "cattle and other animal products" (qo_{ir}); aggregate consumer price for non-beef commodities (pp_{ir}); aggregate prices for non-livestock inputs for beef and other meat processors (pfe_{ijr} and pf_{ijr}); regional income (y_r); and international transportation costs (pt).

The GE simulation revealed significant effects, e.g., $y_{Australia}$=0.5 percent; y_{USA}=-0.04 percent; $qo_{Cattle\_AnimalProds,Australia}$=9.8 percent; and $pf_{Beef,USA}$=-0.04 percent.

Appendix table 1. Product and regional specifications in simulation framework

A. Product classification

	Partial equilibrium model products		General equilibrium (GE) model products
	Bovine meat products	1	Food grains
1	HS 0201.10: Fresh, chilled carcasses	2	Feed grains
2	HS 0201.20: Fresh, chilled bone in	3	Cattle and Animal products n.e.c.
3	HS 0201.30: Fresh, chilled boneless	4	Other farm products
4	HS 0202.10: Frozen carcasses	5	Other natural resource industries
5	HS 0202.20: Frozen bone in	6	Bovine meat products
6	HS 0202.30: Frozen boneless	7	Meat products n.e.c.
7	HS 0206.10: Fresh, chilled of bovine	8	Other food products
8	HS 0206.21: Frozen tongues	9	Other manufactures
9	HS 0206.22: Frozen livers	10	Services
10	HS 0206.29: Frozen other		
11	Rest of GE product no. 6 Bovine Meat Products		
	Meat products n.e.c.		
12	HS 0210.20: Meat of bovine animals		
13	HS 1602.50: of bovine animals		
14	Rest of GE product no. 7 Meat Products n.e.c.		

B. Regional classification

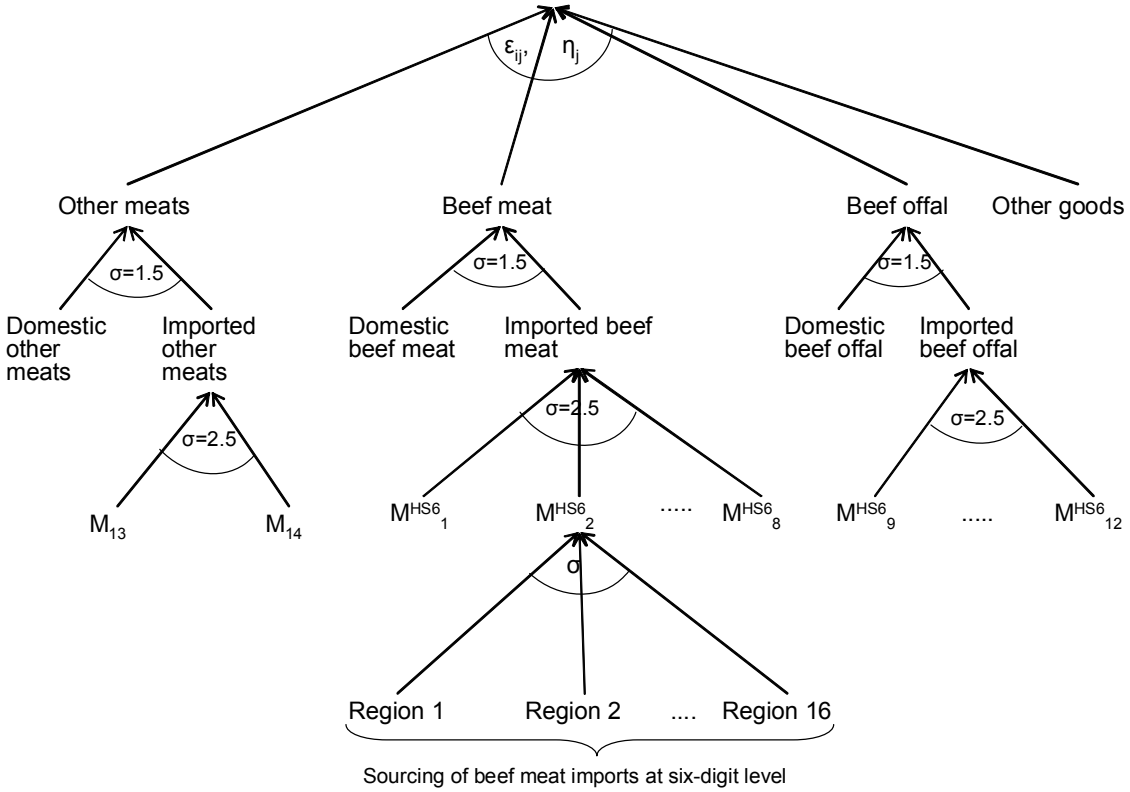
1	Argentina
2	Australia
3	Brazil
4	Canada
5	China, including Hong Kong
6	European Union – 15 Member States as of 1995 (EU-15)
7	European Union – 12 Member States who joined since 2004 (EU-12)
8	Indonesia
9	Japan
10	Korea
11	Mexico
12	New Zealand
13	Rest-of-the-world (ROW)
14	United States
15	Uruguay
16	Russian Federation

Appendix table 2. BSE-related restrictions on beef imports from the United States in 2004, by importing country, percent change in volume of imports

HS heading	Argentina	Australia	Brazil	Canada	China	EU-15	EU-12	Indonesia
0201.10					-100	-32		-98.4
0201.20			-98.3	-85.9	-95.9	-69.2	-98	-68.8
0201.30				-76.5	-100		-24.2	-95.6
0202.10		-99.5			-100		-99.9	
0202.20				-88.1	-99.5	-23.3	-99.9	-85.4
0202.30		-90	-96.3	-73.7	-100	-35.9		
0206.10				-93.2	-78.6	-99.9		-90.8
0206.21				-98.6	-98.4		-99.3	
0206.22			-99.9	-57.6	-99.8			
0206.29	-22.6	-99.9		-44.7	-98.8	-32.3		-43.8
0210.20			-99.8			-99.9		-99.1
1602.50		-100	-77.1	-48.8	-95.9			-100

HS heading	Japan	Korea	Mexico	New Zealand	ROW	Uruguay	Russia
0201.10	-100	-100	-81.5		-42.2	-99.8	-97.8
0201.20	-100	-99.5	-99.5		-37.9	-99.5	
0201.30	-99.9	-100	-33.3		-60.4	-53.5	-82.2
0202.10	-100	-100	-54.3	-98.9	-78.6		-100
0202.20	-99.5	-99.9	-97.8	-76.6	-65.6	-99.2	-100
0202.30	-99.9	-99.9	-41.9	-50.7	-70.3	-26	-99.8
0206.10	-100	-100			-67.9		-99.6
0206.21	-99.9	-100			-71.1		-100
0206.22	-100	-97.9			-76.7		-99.3
0206.29	-96.6	-99.5	-52.8		-57.4	-95.9	-98.5
0210.20	-99.7	-99	-93.1		-80.1		-64.9
1602.50	-97.6	-99.3	-92.5	-99.8	-54.9	-98.7	

Appendix figure 1. Partial equilibrium model: Regional demands for meats and other products



σ: CES substitution elasticity

Appendix figure 2. Partial equilibrium model: Regional supplies of meat products