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EFFECTS OF TARIFFS AND SANITARY BARRIERS ON HIGH- AND LOW-VALUE POULTRY TRADE

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ABSTRACT

A competitive partial-equilibrium spatial model with heterogeneous goods is constructed to evaluate effects of the removal of tariffs, tariff-rate quotas, and sanitary regulations on world poultry trade. The model distinguishes between “high-value” (mostly white meat) and “low-value” (mostly dark meat) poultry products and simulates the trade flows between eight exporting and importing countries and regions. Removing all barriers simultaneously has larger impact on trade than only removing tariffs and tariff-rate quotas. Imposition of sanitary barriers against US products by Russia shifts trade flows, but does not have large net impacts on US producers.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURE

EFFECTS OF TARIFFS AND SANITARY BARRIERS ON HIGH-AND LOW-VALUE POULTRY TRADE

Everett B. Peterson[1] and David Orden[2]

1. INTRODUCTION

World poultry markets are one of the most rapidly growing sectors of the food industry. Poultry production rose six-fold between 1965 and 2002 to over 70 million tons. Consumption increases have exceeded population growth, with world per capita supplies of poultry meat tripling from 3.3 kg to more than 10 kg. International trade has more than kept pace with this industry growth. World exports of poultry meat rose from 375,000 tons in 1965 to over 6.5 million tons in 2002. Thus, trade now accounts for about 10% of world consumption.

The objective of this paper is to evaluate the effects of sanitary barriers to poultry trade in the context of the economic incentives and other trade policy decisions that determine product flows in international poultry markets. Poultry flocks are susceptible to diseases that can spread domestically and across borders. Microbial contamination of poultry for human consumption is also a serious problem in the sector, as with other meats, and is addressed by health regulations in exporting and importing countries. Thus, poultry markets are subject to a complex mix of national and trade sanitary regulations,

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together with non-technical barriers in the form of tariffs and tariff-rate quotas (TRQs). The 1995 World Trade Organization Agreement on Agriculture and on the Application of Sanitary and Phytosanitary (SPS) Measures have, to some extent, affected this mix, reducing levels of non-technical border protection, while tightening the rules for sanitary measures.

To evaluate the policy effects on world poultry trade, a perfectly competitive, spatial partial-equilibrium model with heterogeneous goods is constructed to simulate the trade flows between six key non-composite exporting or importing regions (five countries and the European Union (EU)) and two rest-of-world region aggregates. The model incorporates several extensions of previous work. First, most previous analysis of the economic effects of technical barriers has examined bans on product shipments across a single border (Calvin and Krissoff; Paarlberg and Lee). Since alternative trade opportunities have not been evaluated in these case studies, assessment is precluded of arbitrage occurring through trade "deflection" when a bilateral ban leads other exporting countries to increase their sales to the specific importing region, with the "banned" sales going elsewhere in world markets. As will be seen, there is a complex non-transitive set of existing bilateral poultry sanitary barriers between regions, indicating that trade deflection plays an important role in global poultry markets.

The second extension of previous work in our model is the separate identification of high-value (mostly white meat) and low-value (mostly dark meat) poultry products. Earlier poultry models have aggregated all products into a single category (Alston and Scobie; Kapombe and Colyer; Koo and Golz; Wang, Fuller, Hayes and Halbrendt). Yet, bilateral trade data indicate that most often a country's imports and exports are concentrated in either high-value or low-value products. Maintaining this distinction significantly affects the benchmark model and simulated results of removing non-technical and sanitary trade barriers. Orden, Josling and Roberts provide a simplified model with products differentiated by high and low value but assumed to be homogeneous between regions within each market category.

2. MODEL

A heterogeneous good, spatial partial-equilibrium model with perfect competition affected by non-technical and sanitary trade barriers is used to represent the global poultry sector. There are eight regions in the model: United States (US), Brazil, the EU, Japan, China, Russia, a rest-of-world poultry exporting region (ROWE), and a rest-of-world poultry importing region (ROWM). The non-composite regions were chosen because they account for a significant portion of world poultry production (approximately 70%) and poultry trade (approximately 90% of all exports and 75% of all imports).

POULTRY SECTOR

All production, processing, and distribution activities within each region are aggregated into one industry. This level of aggregation is a simplifying assumption and reflects that for some regions, such as the United States, the production and processing activities are vertically integrated. A positive linear relationship is assumed between an aggregate poultry price and aggregate poultry production.

A wide range of poultry products are traded and are aggregated in the model into two distinct categories: high-value and low-value products. The high-value poultry product includes white meat (breasts and wings) of chicken and turkey along with de-boned meat and specialty items. Low-value poultry is comprised of mainly dark meat (drumsticks and thighs) of chicken and turkey.[3] White and dark meats are produced in essentially equal and fixed amounts per bird and are thus treated as jointly produced goods in the model. The distinction among trade flows in high-value and low-value products is a reflection that most countries mainly import (or export) dark (or white) meat due to the preferences of domestic consumers relative to production. For example, China and Russia import low-value poultry products, the EU imports high-value poultry products, and the US, and also the EU, export low-value products. Brazil, in contrast, exports both high- and low-value poultry parts.

Because of the assumption of joint production, the supply responsiveness of the poultry sector depends on an aggregate poultry price, which is an average of the high-value and low-value poultry prices. Joint production links the high-and low-value supplies and thus affects the simultaneous price determination in both markets. For example, an increase in the high-value poultry price will encourage more high-poultry products to be produced. However, to produce more high-value poultry also entails the production of more low-value poultry products. If the demand for low-value poultry remains constant, then an increase in low-value poultry production would lead to a

[3] The distinction between white and dark meat product categories is consistent with industry characterizations of the poultry market. See Fuller.

reduction in the price of low-value poultry. This low-value price reduction would offset some or possibly all of the high-value price increase, reducing the incentive to expand poultry production.

Formally, the relationship between the high-value and low-value poultry prices and the poultry supply response can be seen using the definition of the aggregate poultry price:

(1) $$P_A = 0.5P_H + 0.5P_L,$$

where P_A is the aggregate poultry price, P_H is the high-value poultry price and P_L is the low-value poultry price. Totally differentiating equation (1) and converting the differentials to percentage changes yields:

$$\hat{P}_A = \frac{0.5P_H}{P_A}\hat{P}_H + \frac{0.5P_L}{P_A}\hat{P}_L.$$

Multiplying each term on the right-hand side by q_A/q_A, where q_A is quantity of aggregate poultry production and noting that $q_H = q_L = 0.5q_A$:

(2) $$\hat{P}_A = \frac{0.5q_A P_H}{P_A q_A}\hat{P}_H + \frac{0.5q_A P_L}{P_A q_A}\hat{P}_L = \frac{q_H P_H}{P_A q_A}\hat{P}_H + \frac{q_L P_L}{P_A q_A}\hat{P}_L = r_H\hat{P}_H + r_L\hat{P}_L,$$

where r_H and r_L are the revenue shares of high-value and low-value poultry products. The percentage change in the aggregate poultry price is a revenue share weighted average of the percentage changes in the individual poultry prices. Any combination of changes in high-value and low-value poultry prices that increase the aggregate poultry price will lead to an increase in both high-value and low-value poultry output.

CONSUMER DEMAND

Consumer demand for poultry products in each region is represented by a four-level nested Constant Elasticity of Substitution (CES) demand system (see figure 1). At the bottom level, consumers choose among alternative sources of imported high-value poultry products or low-value poultry products, respectively. We have chosen to use an Armington specification due to the variation in unit value across exporters for a given importing region (see table 1). This price variation indicates there are some differences across countries in the specific types of high- or low-value products being traded. Thus, the low-value poultry being exported from the US is not exactly the same products as the low-value poultry from the EU or Brazil.

In the second-level of the nested CES demand system, consumers choose between a domestically produced and an aggregate imported high-value or low-value poultry product. So if imports become more expensive relative to domestically produced poultry, consumers will substitute away from imports. At the third-level, consumers choose between aggregate high-value and low-value poultry products. If the aggregate price of high-value poultry, which is a function of the price of imports and the domestic price of high-value poultry, increases relative to the aggregate price of low-value poultry, consumers will increase their consumption of low-value poultry and decrease their consumption of high-value poultry. At the top-level of the demand system, consumers choose between an aggregate poultry product and all other products. This allows for consumers to increase or decrease their overall consumption of poultry products as the aggregate relative price of poultry changes.

Figure 1—Structure of Consumer Preferences

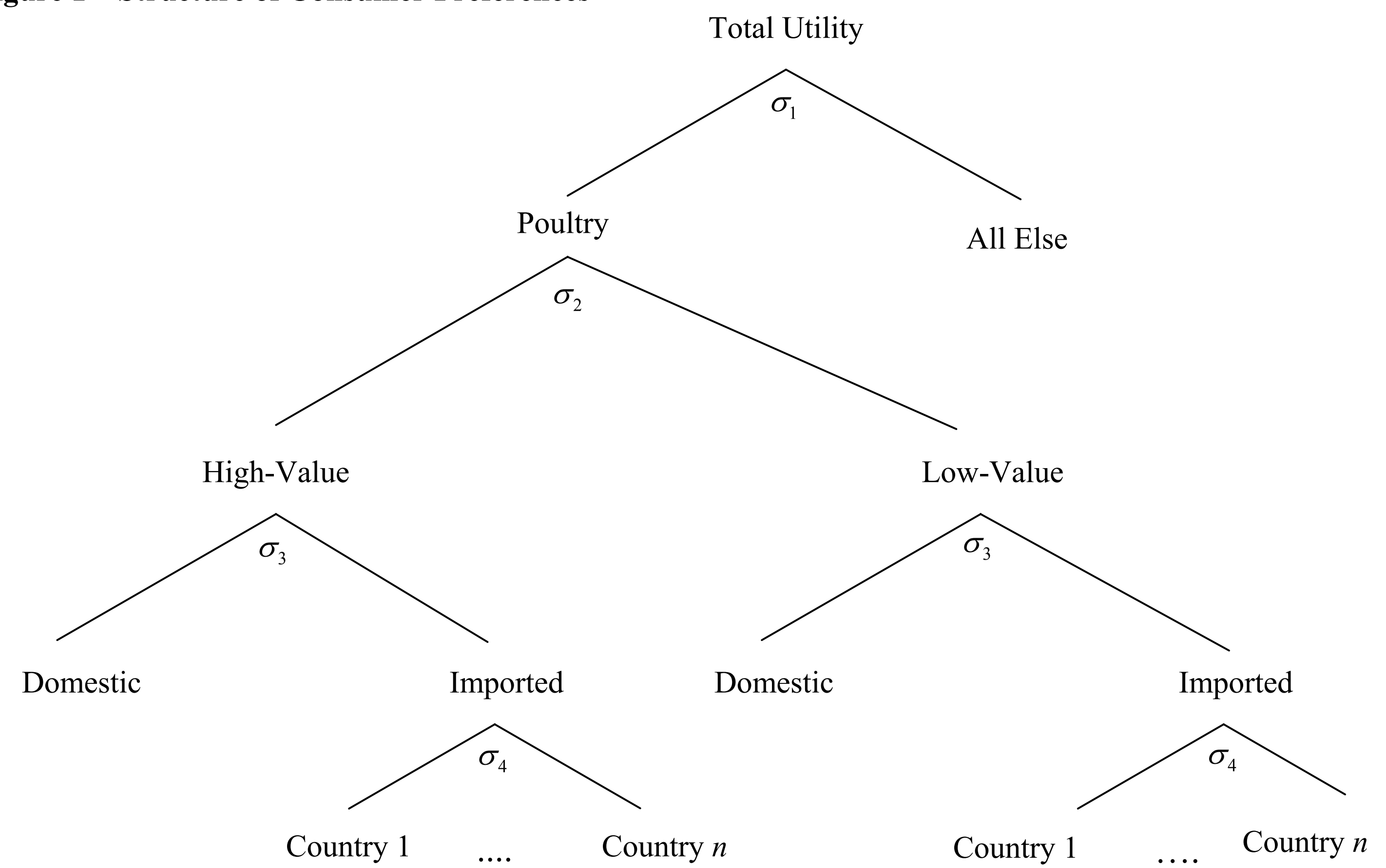

Table 1—Unit Value of 1998 World Poultry Trade, SITC Code 01235, US Dollars per Metric Ton

	Importers							
							All Others	
Exporters	**US**	**Brazil**	**EU**	**China**	**Japan**	**Russia**	**High-Value**	**Low-Value**
US	--	--	--	647	1112	719	--	808
Brazil	--	--	2505	717	1940	--	1774	--
EU	--	--	--	936	--	712	--	710
China	--	--	--	--	1890	--	1563	--
All Others								
High-Value	--	--	3264	--	2060	--	--	--
Low-Value	--	--	--	798	--	885	--	--

Source: International Bilateral Agricultural Trade Database, Economic Research Service, USDA, developed from the United Nations Conference on Trade and Development bilateral SITC trade data.

Note: The trade data contained several instances of very small trade flows, generally less than 500 metric tons between regions in the model. Because of their small magnitudes and likelihood that they represent trade in specialty poultry products, these trade flows are dropped from the benchmark trade flows.

GOVERNMENT POLICIES

The base year of the model is 1998. During that year, all non-composite regions imposed tariffs on imported poultry products. Table 2 summarizes the tariff levels imposed by these regions. The Japanese import market has the lowest tariffs of all of the non-composite regions. This in part reflects the Japanese government's encouragement of foreign investment by Japanese poultry firms in Brazil, Thailand, and China. The EU restricts poultry imports through TRQs, which are allocated to Brazil, Canada, Mexico, and countries in Central and Eastern Europe that have quota-restricted preferential access under the Europe Agreements, and imposes prohibitive over-quota tariffs. Both the US and Brazil use tariffs to protect their poultry markets even though they are relatively low-cost exporters.

Because poultry flocks are susceptible to infectious diseases and microbial contamination of poultry meat is a serious problem, many countries have sanitary regulations that impose restrictions on exports from one or several countries. Table 3 summarizes whether there are binding sanitary (SPS) barriers between the six non-composite regions in the model.

Table 2—Summary of Tariffs Rates Imposed by Non-Composite Regions

Region	Tariff Rates	Average Rate
US	Tariffs bound at $0.088/kg for whole chicken and $0.176/kg for parts (18-36 % ad valorem).	25%
Brazil	Tariffs bound in the WTO at 35 % on all poultry products.	35%
China	Tariffs of 45 % on all poultry products.	45%
EU	Tariff of 299 ECU/mt. on whole chicken and 358 ECU/mt. on parts (18-60 % ad valorem). Tariff-rate quotas established with quantities allocated to Brazil and Central and Eastern European countries.	20%
Japan	Tariffs of 11.9 % on whole chicken and 8.5 % on parts.	10%
Russia	Tariffs of 30 % on chicken and 15 % on turkey. Trade agreement with EU gives no special access to European imports. Restrictions on transshipments through Baltic countries.	22.5%

Source: USITC, USDA, and WTO Schedules

Table 3—Bilateral SPS Barriers to Poultry Trade

	Importers					
Exporters	US	Brazil	EU	China	Japan	Russia
US		Banned	Banned	Allowed	Allowed	Allowed
Brazil	Banned		Allowed	Allowed	Allowed	Allowed
EU	Allowed	Allowed		Allowed	Allowed	Allowed
China	Banned	Banned	Banned		Allowed	Allowed

Source: Authors' review of trade-related regulations.

One might expect that these regions would divide into two groups, those free of highly-infectious poultry diseases and those that are not free of disease, with trade occurring within each group. However, this is not the case. The major importers of poultry products, China, Japan, and Russia, accept imports from all exporting regions in the model. The two major exporters, the US and Brazil, do not accept imports from each other and also ban imports from China, based on recurrent outbreaks of Newcastle Disease. The EU also bans imports from the US and from China. The main point of disagreement between the US and the EU is on the use of end-of-line chlorine decontamination in US processing facilities. The EU does not consider this to be equivalent to trisodiummonophosphate or lactic acid decontamination, and therefore has banned poultry imports from the US. Imports of poultry from Brazil into the US are banned based on intermittent outbreaks of poultry diseases in Brazil. The EU does not block imports from Brazil due to disease problems. Finally, Brazil's SPS barrier against imports from the US is based on the decision that the inspection system for poultry processing plants in the US is not equivalent to its own. Thus, diverse sanitary barriers applied differently among countries lead to a complex set of trade opportunities.

DATA

The benchmark bilateral trade flows are obtained from the USDA International Bilateral Agricultural Trade Database that is adopted from trade data of the United Nations and contains information on the quantity, in metric tons, and the value of poultry trade in each category[4]. The UN trade data distinguishes six, five-digit SITC categories

[4] Access to the trade data was provided by Mark Gehlhar, ERS/USDA.

for trade in poultry products. These SITC categories separate poultry into whole birds, cuts, and livers, as well as between fresh or chilled and frozen. The dominant SITC category is 01235, “Poultry cuts and offal (other than livers) frozen,” which accounts for nearly 70% of world (excluding intra-EU) poultry trade. Because of our interest in differentiating the distinct markets for high-value and low-value poultry products, we focus our analysis on these frozen poultry cuts. The next largest category is SITC 01232, “Poultry not cut in pieces, frozen,” which accounts for approximately 20% of world poultry trade. We exclude this and the other four categories to retain tractability in our differentiated-product model.

The bilateral trade flows within the category of frozen poultry cuts were assigned to either high-value or low-value products based on the unit values computed from the data (see table 1). For example, Brazilian exports to Japan and the EU (with unit values of \$1940 and \$2505, respectively) are assumed to consist of high-value poultry products, while Brazilian and US exports to China, or US exports to Russia (with unit values of \$717, \$647 and \$719, respectively) are assumed to consist of low-value poultry products. Table 4 shows quantities of the benchmark bilateral trade flows in high-value and low-value products on this basis. The only gray area in this dichotomy is US exports to Japan, whose unit value does not appear to fit in either category. In examining the US trade data at the 10-digit HS level, approximately 70 percent of US exports to Japan are in the category “0207140090” which is defined as “frozen other cuts/edible offal (inc livers).”

Table 4—Benchmark Data

Country	Production	Price	Domestic Consumption (+), Exports (+), or Imports (-)								
			US	Brazil	ROWE	EU	China	Japan	Russia	ROWM	Net Trade
High-Value	(Million MT)	$/MT					(Million MT)				
US	7.619	1950	7.619								0.000
Brazil	2.485	1850		2.328		0.043		0.067		0.047	0.157
ROWE	2.841	1800			2.654	0.062		0.125			0.187
EU	4.446	2900		-0.043	-0.062	4.552					-0.105
China	5.675	1750					5.428	0.194		0.054	0.247
Japan	0.606	2200		-0.067	-0.125		-0.194	0.991			-0.385
Russia	0.345	2205							0.345		0.000
ROWM	7.206	2000		-0.047			-0.054			7.306	-0.101
Total HV	31.222										
Low-Value											
US	7.619	485	5.581				0.491	0.076	0.683	0.789	2.038
Brazil	2.485	545		2.349			0.136				0.136
ROWE	2.841	600			2.715		0.126				0.126
EU	4.446	600				3.871	0.139		0.145	0.292	0.576
China	5.675	1100	-0.491	-0.136	-0.126	-0.139	6.565				-0.891
Japan	0.606	750	-0.076					0.682			-0.076
Russia	0.345	925	-0.683			-0.145			1.172		-0.827
ROWM	7.206	800	-0.789			-0.292				8.287	-1.081
Total LV	31.222										
Total	62.444										

Sources: Production from FAOSTAT; trade flows from International Bilateral Agricultural Trade Database, Economic Research Service, USDA, developed from the United Nations Conference on Trade and Development bilateral SITC trade data; domestic prices derived from model calibration by the authors.

Because nearly all of US exports to China and Russia also fall in the same category, and to avoid creating a second low-value products classification in the model, we assume that US exports to Japan are low-value products.[5] Given the relatively small amount of US poultry exports to Japan (76,100 metric tons), this abstraction should not substantially affect the model results.

The level of poultry production for each region is given in the first column of table 4. It is the 1998 estimate of poultry meat production (obtained from the Food and Agriculture Organization FAOSTAT database). The level of poultry production in the two composite regions is determined by first identifying which countries are net poultry exporters in FAO trade data. Then, the level of poultry production in the ROWE region is the sum of production in these exporting countries. Poultry production for the ROWM region is obtained by subtracting the quantity of poultry meat produced in China, the EU, Brazil, Japan, Russia, the US, and the ROWE region from world poultry production.

Data on domestic prices of high and low-value poultry products by region were not available. The general magnitude of these prices can be inferred from the reported unit trade values and estimated transportation costs shown in table 5. Exact domestic prices for each region for the base case scenario were determined as part of the model calibration process.

[5] When comparing the unit export values within the 10-digit HS category between Japan, China, and Russia, the unit export value to Japan were approximately 50% higher, indicating that even within this narrow HS category there are product or quality differences.

Table 5—Transportation Costs

	US	Brazil	EU	China	Japan	Russia	ROWE	ROWM
					Dollars per mt.			
US	--	190	180	222	205	212	250	275
Brazil	190	--	190	260	252	200	250	211
EU	180	190	--	203	235	214	250	239
China	222	260	203	--	139	240	211	285
Japan	205	252	235	139	--	235	174	250
Russia	212	200	214	240	235	--	250	250
ROWE	250	250	250	211	174	250	--	350
ROWM	275	211	239	285	250	250	350	--

Source: Author's estimates from limited available ocean freight rates.

CALIBRATION

The calibration process for the CES demand system begins at high- and low-value import sub-utility functions because it is the level where both initial quantities and expenditure are observed. The CES utility and sub-utility functions, for each region *i*, for each level of the demand system in figure 1 can be expressed as:

(3) $$U = \left\{ \sum_{j=1}^{n} \alpha_j^{1/\sigma} x_j^{\frac{\sigma-1}{\sigma}} \right\}^{\frac{\sigma}{\sigma-1}}, \sum_{j=1}^{n} \alpha_j = 1,$$

where α_j is a shift parameter to be determined during calibration, x_j is the quantity of good *j* consumed, *n* is the number of goods consumed, σ is the elasticity of substitution for that level in the nested CES demand structure, and the regional subscript *i* is suppressed for simplicity. The resulting demand function and true cost-of-living price index for each level are then:

(4) $$x_j = \frac{\alpha_j p_j^{-\sigma} I}{\sum_j \alpha_j p_j^{1-\sigma}} \text{ and}$$

(5) $$P_M = \left\{ \sum_{j=1}^{n} \alpha_j p_j^{1-\sigma} \right\}^{\frac{1}{1-\sigma}},$$

where I is total or group expenditures, p_j is the price of good j, and P_M is the price index.

Typically, equation (4) is calibrated by rescaling all prices to equal one and setting the values of α_j equal to the associated import share of that good from region j into region i. A problem with this approach is that if region j does not export to region i in the initial equilibrium, α_j is set equal to zero which then bars the possibility of region j from exporting to region i after reform of trade policies occurs. Because removing trade barriers could alter the observed pattern of trade, this method of calibrating the α_j is clearly constraining. By assuming instead that all $\alpha_j = \alpha$ for those countries exporting to a given region in a given scenario, then α_j can be eliminated from equations (4) and (5).[6] The implication of assuming all $\alpha_j = \alpha$ is that imports from each region with which trade is considered feasible are consumed in equal amounts if all import prices are the same. A limitation of the assumption that all α_j's are assumed to be equal is that the calibrated prices can not be made to exactly match the data-derived export unit values for all regions. This is because the differences in relative import quantities are strictly due to relative price differences, whereas choice of unique α_j's for each exporting region reflects other demand factors affecting relative import levels.

[6] This is due to the ordinal properties of all utility functions. If all α's are equal in equation (2), then a monotonic transformation will allow them to be removed without altering the preference structure of the utility function.

Using equation (4) under our assumption on the α_j's, the prices of imported high-value or low-value poultry products are determined to replicate the benchmark trade flows and total expenditures on imports by each region. The values of the calibrated import prices are also a function of the value of the elasticity of substitution between import sources (σ_4 in figure 1). The smaller the value of this elasticity, the larger will be the calibrated import price differentials between regions. Various values for the import elasticity of substitution were tried during the calibration process. Values of less than 10 resulted in much larger price differentials than the differentials in unit export values while values over 10 did not reduce the price differentials substantially. Therefore, the elasticity of substitution between imports is assumed equal to 10 for all regions.[7]

To illustrate the price calibration process, consider the imports of high-value poultry into Japan. In the benchmark, three regions, Brazil, China, and the ROWE export 385,100 mt. of high-value poultry to Japan at a value of $752.4 million. A system of three equations, representing the quantity of high-value poultry imported from each region, in three unknowns, the import prices, is then solved.[8] The resulting import prices are tariff inclusive c.i.f. prices. Continuing with the Japan example, the calibrated high-value import prices per mt. for the base model scenario are $2,312 for Brazil, $2,078 for China, and $2,172 for ROWE. Corresponding base case domestic poultry prices were calculated from these results. Dividing the calibrated import price by the one plus the tariff rate and then subtracting the transportation costs given in table 5 determines the

[7] Alston and Scobie considered two different values for this parameter, 3 and 36, in their analysis. We use a value of 5.0 in conducting a sensitivity analysis of our results.
[8] The system of nonlinear equations is solved using the CNS solver in GAMS.

domestic price for each of the exporting countries, as shown in table 4.[9] The domestic price of high-value poultry in Japan is estimated to approximately equal the average import price.

For low-value poultry, the domestic price for the US and the EU are averages of the calibrated tariff-inclusive c.i.f. prices for China and Russia adjusted for the tariffs and less transport cost (ROWM is excluded from the averages because transportation costs are not known). For Brazil, the domestic low-value price is based on the calibrated c.i.f. price for China. For China, Russia, and ROWM, the domestic low-value poultry price is set equal to the average tariff-inclusive c.i.f. import price in each region. For Japan, the import price and domestic price of low-value poultry are set at the domestic US price plus transportation costs and tariffs.

While the domestic prices for most high-value and low-value product can be determined from the calibrated import prices, tariffs, and estimated transport costs, alternative methods must be used for regions that do not export or import a given poultry product. For the US, the high-value poultry price is set equal to an average wholesale price of chicken breast, chicken wings, and turkey breast (USDA, AMS). For Russia, the domestic high-value price is set equal to the average domestic high-value price in Brazil, China, and ROWE times the 22.5 percent tariff rate. Thus, the domestic high-value price in Russia would be less than the domestic price of the potential exporters plus transport cost. This assumption is made because Russia does not import any high-value poultry and a domestic price less than the exporter's price plus transport cost would discourage

[9] The transportation costs were adjusted slightly in order to round the poultry prices to the nearest $5/mt.

high-value exports to Russia. Finally, because of the TRQ in the EU, the calibrated high-value import prices are not considered accurate reflections of the EU domestic prices. In 1998, the average wholesale price for young chickens was approximately $1,750 per metric ton (European Commission). Thus, the EU high-value poultry price was computed such that the simple average of the domestic high-value and low-value price equals $1,750.

Remaining Demand Parameters

Once domestic prices for all products have been calculated, the parameters in the remaining CES utility and sub-utility functions can also be determined. Since all the remaining groups in the nested CES have only two goods, equation (4) is modified to:

$$x_j = \frac{\alpha p_j^{-\sigma} I}{\alpha p_j^{(1-\sigma)} + (1-\alpha) p_m^{(1-\sigma)}}. \tag{6}$$

For example, consider the sub-utility functions that govern the substitution between domestic and import high-value (low-value) poultry products. Then x_j is the quantity of the domestic poultry product consumed, p_j is the domestic price, p_m is the import price index, determined using equation (5), σ is the elasticity of substitution between domestic and imported products (i.e., the Armington elasticity or σ_3 in figure 1), and *I* is expenditure on high-value (low-value) poultry products. Once an elasticity of substitution is chosen, the only unknown parameter that needs to be chosen is the shift parameter α.

Values for σ_1 and σ_3 in each region are obtained from the Global Trade Analysis Project (GTAP) database. The elasticity of substitution between poultry and all else (σ_1) is set equal to the Allen partial elasticity of substitution between the GTAP commodity "other meat products" (which includes poultry meat) and an all other commodity aggregate for each region (see table 6). Given that the budget share for all poultry products is small, the value of σ_1 basically determines the aggregate own-price demand elasticity for poultry.[10] The Armington elasticities in the GTAP database vary across products, but not across regions. We use a value of 2.5, which is an average between the two GTAP commodities that include live and processed poultry products.

No estimates of the elasticity of substitution between high-value and low-value poultry products (σ_2) were available. Because of the strong consumer preferences for either white or dark meats in various regions, such as the preference for white meat versus dark meat in the US and the converse in Brazil and Russia, it is assumed that substitution possibilities in demand between high-value and low-value products is limited. Therefore, we assumed an elasticity value of 0.5 for all regions. Based on the assumed values of the elasticities of substitution and the initial consumption budget shares, all poultry products are gross substitutes for one another in all regions.

The implied own-price uncompensated demand elasticities for high-value and low-value poultry for all regions are given in table 6. In general, the demand elasticities

[10] The aggregate demand elasticity for poultry is equal to $s_A(\sigma_1 - 1) - \sigma_1$, where s_A is the budget share for all poultry products.

for domestically produced products are inelastic while the elasticities for imports are elastic. This difference is due to much smaller consumption shares for imports. The relatively larger demand elasticities in Japan are due to smaller poultry consumption shares. These demand elasticities are within the ranges used by previous studies.[11]

Table 6—Demand Elasticities at Initial Prices

Region	σ_1 [a]	Own-Price Demand Elasticity[c]			
		DHV[b]	IHV	DLV	ILV
US	0.30	-0.33		-0.47	
Brazil	0.20	-0.27		-0.43	
ROWE	0.15	-0.24		-0.41	
EU	0.20	-0.30	-2.45	-0.46	
China	0.25	-0.36		-0.60	-2.30
Japan	0.40	-1.17	-1.75	-0.80	-2.18
Russia	0.10	-0.32		-1.72	-1.06
ROWM	0.20	-0.32	-2.47	-0.68	-2.23

[a] Elasticity of substitution between poultry products and all other products in consumers' utility function in figure 1. The other elasticities of substitution in figure 1 do not vary across countries. The assumed values of σ_2, σ_3, and σ_4 are 0.5, 2.5 and 10 respectively.

[b] The abbreviations DHV, IHV, DLV, and ILV stand for domestic high-value poultry products, imported high-value poultry products, domestic low-value poultry products, and imported low-value poultry products. Cells without an entry represent zero consumption in the benchmark data set.

[c] The unconditional own-price elasticities for a nested CES utility function are derived based on the formula from Keller for the own-price Allen partial elasticities of substitution. For example, the own-price Allen partial elasticity of substitution for domestic high-value poultry products is:

$$\sigma_{DHV} = -\left[\sigma_3\left(c_{DHV}^{-1} - c_{HV}^{-1}\right) + \sigma_2\left(c_{HV}^{-1} - c_p^{-1}\right) + \sigma_1\left(c_P^{-1} - 1\right)\right],$$

where c_{DHV}, c_{HV}, and c_P are the initial budget shares of domestic high-value poultry, all high-value poultry, and all poultry respectively. Then, the unconditional own-price demand elasticity for domestic high-value poultry, noting that the CES utility function is homothetic, is defined as:

$$\varepsilon_{DHV} = c_{DHV}\left(\sigma_{DHV} - 1\right).$$

The same procedure is utilized for the other poultry products.

[11] Koo and Goltz assume perfectly inelastic demand, Alston and Scobie use a demand elasticity of -0.5 for all regions, Beck *et al*. use demand elasticities of -0.56 for broilers and -1.09 for turkey, and Wang *et al.* see poultry demand elasticities of -1.33 and -0.53 for urban and rural consumers in China.

Supply Response

Little empirical evidence exists on poultry supply elasticities across regions. Wang *et al.* assumed a supply elasticity of 1.175 for China. Kapombe and Colyer estimated a supply response of 0.13 for US broiler production. Because of the lack of supply elasticity estimates across regions, we consider two difference scenarios. The first scenario is a long-run scenario where regions have time to build more production and processing facilities. For this scenario, we follow Alston and Scobie and assume an aggregate supply elasticity of 5 across regions.[12] The second scenario is a short-run scenario where we assume an aggregate supply elasticity is 0.5 for all regions.

3. RESULTS

The model developed in the previous section is used to analyze the impacts on the global poultry sector of four alternative policy changes. First, we remove all tariffs and the EU TRQ among the six non-composite regions but leave any sanitary (SPS) barriers in place. Second, we remove only the SPS barriers. Third, we remove all trade barriers among the six non-composite regions, a "free trade" scenario. The final policy change is drawn from recent events, a Russian ban on low-value imports from the United States (see Ames for the chronology of one recent dispute). In the base case model scenario, production, domestic prices and trade flows shown in the first column of table 7 (see page 33) match table 4.

[12] The parameters of the linear aggregate poultry supply function are chosen such that the aggregate supply elasticity at initial prices is equal to 5 or 0.5 respectively.

REMOVAL OF TARIFFS AND TRQs

In analyzing this policy change, we consider four different scenarios. Given the uncertainty of the magnitude of poultry supply elasticities, we conducted this experiment using the two supply responses discussed in the previous section. In addition, we consider scenarios where liberalization could change the existing trade patterns. In particular, we analyze the case where Brazil becomes an exporter of low-value poultry to Russia and the ROWM region. Given the growth of the Brazilian sector into a major player in poultry export markets, there is some potential for Brazil to enter these two markets. The order of discussion of these scenarios begins with the longer-run supply elasticities maintaining the existing trade patterns, and then considers changes in the trade patterns using the same supply elasticities. The last two scenarios use the shorter-run supply elasticities.

Long-run Supply Elasticities

The removal of all tariffs and TRQs results in the reduction of the relative price of imported poultry products in all importing regions. This results in an increase in the demand for imported poultry products in those regions. Trade in high-value and low-value poultry products increases by 913,000 mt, or 26.3% (see table 7, columns 1 and 2). Because low-value poultry products accounts for the majority of poultry trade in the base case, approximately two-thirds of the trade increase is in low-value products.

The regional impacts depend on import and export patterns of that region and on the magnitude of liberalization. For example, the US is a larger exporter of low-value products, but does not trade high-value products. Tariff liberalization results in an increase in US low-value exports by 282,000 mt or 13.8%. The largest increase in exports is to China, which has the largest tariff reduction, followed by an increase in exports to Russia.[13] To satisfy the increase in export demand for low-value products, the US must increase poultry production and/or decrease domestic consumption of low-value products. The US low-value poultry price increases by 8.0%, achieving both an expansion in production and a decrease in domestic demand from consumers substituting high-value products for low-value products. Because of the joint nature of poultry production, an expansion in production implies an increase in both high-value and low-value poultry products. If the expansion in production is greater than the substitution effect in demand, then the price of high-value products will fall. This is the case for the US, with the price of high-value poultry declining by 1.8%. Note that this decrease in the US high-value price limits the expansion in US poultry production because it offsets some of the increase in the US low-value price, making the increase in the US aggregate poultry price smaller. When taking these two effects into account, US poultry production increases by 0.9% or 130,000 mt.

The impacts of liberalization on Brazil and the aggregate exporting region (ROWE) are similar because these regions export both high-value and low-value products in relatively equal proportions. Again, because both poultry products are produced in equal, fixed proportion, the increase in exports can be accomplished with an

[13] Bilateral trade flows are not shown for the scenarios in table 7 but are available from the authors on request.

expansion in production without requiring large relative poultry price changes. The prices of high-value poultry increase by 1.8% and 1.6% respectively in Brazil and the ROWE while low-value poultry prices increase by 2.5% and 2.3% respectively. Because the prices of high-value and low-value poultry products both increase, the aggregate poultry price increases by a larger percentage in Brazil and ROWE compared to the US. Thus, there is a larger expansion in poultry products in these regions (6.1% for Brazil and 5.0% for ROWE) than in the US.

China and the EU experience different effects from liberalization because they are importers and exporters of poultry products. Thus liberalization will result not only in an increase in demand for each region's exports, but an increase in import demand by each region as imports become relatively cheaper than domestic poultry. The impact on poultry production and prices in China and the EU depends on the relative strength of the increase in exports versus imports. China is a much larger importer of low-value poultry than an exporter of high-value products. Coupled with the largest decrease in tariffs, this results in an increase in low-value imports by 646,000 mt while exports remain essentially constant (a small 20,000 mt decrease). The decrease in the demand for Chinese low-value poultry results in a 9.1% drop in the price of this product. This price reduction in turn leads to a reduction in Chinese poultry production and therefore a reduction in supply of both high-value and low-value products. Because the decrease in the supply of Chinese high-value poultry is greater than the decrease in demand (due to Chinese consumers substituting relatively lower price low-value poultry for high-value poultry), the Chinese high-value poultry price increases by 4.7%. In the EU, the removal of the TRQ results in a larger increase in high-value imports (257,000 mt) than the increase in low-value exports (22,000 mt). Because of the larger decrease in demand for EU high-value products relative to the increase in export demand for EU low-value products, the EU high-value poultry price declines, reducing the aggregate EU poultry price and therefore EU poultry production. Again, because of the assumption of joint production, a drop in EU poultry production reduces the available supply of EU low-value poultry. Thus, the increase in export demand coupled with a decrease in supply leads to an increase in the price of EU low-value poultry.

Russia is an importer of low-value poultry products. The removal of tariffs on imported low-value poultry products reduces the price of imports versus domestically produced low-value poultry for Russian consumers, causing consumers to substitute imported low-value poultry for domestically produced low-value poultry. The decrease in demand for Russian low-value poultry leads to a 9.6% price reduction and a 3.9% reduction in Russian poultry production. The demand for Russian high-value poultry also decreases as consumers substitute to the relatively less expensive low-value products. However, this decrease in demand is less than the decrease in Russian high-value poultry supply, causing the price of Russian high-value poultry to increase by 2.9%.

Both Japan and the aggregate importing region (ROWM) import both high-value and low-value poultry products. However, the ROWM is not included in the assumed reduction of trade barriers because of limited information about trade policies of the countries. Therefore, the effects of liberalization are different for these two regions. In the initial benchmark, Japan imports roughly five times more high-value poultry products than low-value poultry products. Thus, the removal of Japanese tariffs has a larger impact on Japanese high-value products than low-value products. Due to the decrease in the relative price of imports, Japanese purchases of imported high-value products increase by 35,000 mt while the purchases of low-value products increase by 11,000 mt. The substitution of imported poultry products for domestically produced poultry products decreases the demand for Japanese poultry, leading to a 3.2% reduction in the Japanese poultry production and a 1.8% decrease in the Japanese price of high-value products. However, because the drop in the production of low-value Japanese poultry is greater than the decrease in demand, its price increases by 2.8%. In the ROWM region, liberalization by other countries results in the prices of imported poultry increasing relative to domestically produced poultry. This causes consumers in the ROWM to substitute domestically produced poultry for imports, increasing the demand for ROWM poultry. Because the ROWM region imported approximately 10 times more low-value poultry in the initial equilibrium, there is a much larger increase in the demand for ROWM low-value poultry versus high-value poultry. However, the expansion in ROWM poultry production to meet this increase in demand results in equal increases in high-value and low-value poultry production. Thus, while the price of ROWM low-value poultry increases, the price of ROWM high-value poultry decreases.

Entry of Brazil into New Markets

The third column in table 7 reports the results for the scenario where tariffs and the EU TRQ are removed and Brazil enters new markets to export low-value poultry to Russia and the ROWM using the long-run poultry supply elasticities. In this scenario, Brazil becomes a direct competitor with the US and the EU in the Russian and ROWM low-value poultry markets. This new entry leads to both a substitution and expansion effect (stemming from the assumed demand structure) in those markets. Holding expenditures on imported low-value poultry products constant, new entry leads to a reduction in market share for all incumbents. However, since the CES demand structure is “variety loving,” the price index of imported products decreases with new entry leading to an expansion in imports. For the US and the EU, the substitution effect dominates the expansion effect with exports to Russia and the ROWM declining compared to the base case. For Brazil, the substitution and expansion effects in Russia and the ROWM reinforce one another, leading to roughly a 300% increase in Brazilian low-value exports. This is a much larger increase in Brazilian low-value exports compared to the previous scenario.

The main impact from the larger increase in Brazilian low-value exports is that the price of Brazilian low-value poultry increases relative to the US and EU low-value poultry prices. This is opposite compared to the previous scenario. This helps the US and the EU increase their sales of low-value poultry to China, due to the substitution effect, and allows both countries to offset some of their lost sales in Russia and the ROWM. However, compared to the previous scenario, the US and the EU experience smaller increases in the price of low-value products and the US has a smaller overall increase in poultry production (51,000 mt) while the EU experiences a larger overall decrease in poultry production (39,000 mt).

Short-run Supply Elasticities

In the short-run, because poultry producers cannot respond as much to changes in poultry prices, one would expect that trade liberalization would have smaller effects on production and trade, compared to the long-run. This can be seen by comparing columns two and four or columns three and five in table 7. All regions experience a smaller increase or smaller decrease in poultry production in the short-run compared to the long-run. Because of the smaller production expansion in poultry exporting countries, there is a 10-15% smaller increase in high-value poultry trade and approximately 5% smaller increase in low-value poultry trade in the short-run.

With an inelastic supply response, one would also expect that trade liberalization would have larger impacts on prices changes compared to a longer-run scenario with more elastic supply. However, due to the joint production of high-value and low-value poultry products, this is not always the case. For example, the decrease in the price of US high-value poultry is smaller in the short-run than in the long-run. This is because of a smaller increase in US poultry production in the short-run puts less downward pressure on the US high-value price. Similarly, there is a smaller increase in the Chinese high-value price and the EU low-value price. Smaller reductions in poultry production in both regions in the short-run imply relatively larger supplies and smaller price increases.

Finally, a smaller reduction in Russian poultry production in the short-run provides enough additional high-value poultry such that the price decreases in the short-run compared to a price increase in the long-run.

Sensitivity Analysis

Because the base value of 10 for the elasticity of substitution among import sources (σ_4 in figure 1) may be considered "high" by some, we also examined the four previous scenarios using an elasticity of substitution of 5 among import sources.[14] The effect of reducing this parameter is to lessen the substitution effect between competing imports relative to the expansion effect of lower import prices from the removal of existing tariffs. Because the majority of poultry trade is in low-value products and the US is the least cost low-value producer, a smaller substitution effect means smaller increases in US low-value exports. When the existing trade patterns are maintained, the gain in US low-value exports are 40% to 50% lower (long-run and short-run). If Brazil enters the Russian and ROWM low-value poultry markets, then US low-value exports do not significantly increase.

[14] Again, the results are not shown but are available on request.

REMOVAL OF SPS BARRIERS

In this scenario, all of the SPS barriers listed in table 3 are removed.[15] With the EU's TRQs still in place, removal of the SPS barriers on US and Chinese imports is moot because these countries do not have quota rights. Thus, only the US's ban on Brazilian and Chinese poultry products and Brazil's ban on US and Chinese poultry products are effectively removed. Since the US is a large exporter of low-value poultry, it is only likely that Brazil or China would export high-value poultry products to the US. But given the size of the US poultry sector and the differences in the bases prices plus transportation costs, it is unlikely that the lifting of the US SPS sanctions would generate a significant amount of export sales. The same is true for US or Chinese exports to Brazil. Thus, removing these barriers alone does not really create the potential for increased trade.[16]

FREE TRADE

In this scenario, all non-technical and SPS barriers are simultaneously removed. The most important effect comes from the removal of the EU's TRQs and SPS barriers that we assume allows for access to the EU high-value poultry market for US poultry

[15] This does not necessarily imply that all such regulations are unnecessary or protectionist in intent. Full risk-based evaluation of the impact of alternative sanitary regulations and the consequences of their modification are needed to complete judgments about whether a particular regulatory barrier is an efficient and effective way of controlling health dangers. Here, we limit our analysis to the effects of removing these barriers between our aggregated regions, without providing a full assessment of whether doing so would raise sanitary risks among these trading partners.

[16] These are not the strongest results from our model because in the absence of any imports by Brazil or the US in the benchmark data a preference for imports would have to be arbitrarily specified to induce any trade. We chose not to set a non-zero value of this parameter on the basis of the arguments given in the text.

producers.[17] The main impact of this policy change, seen by comparing the results in columns six through nine with those in columns two through five in table 7, is an expansion of US high-value and low-value exports relative to other exporters. Focusing on the long-run results, with new market access to its high-value poultry market, the US exports around 100,000 mt of high-value poultry to the EU. Compared to the base case, the drop in the US high-value poultry price is less when all trade barriers are removed than with only the non-technical trade barriers removed. This leads to a greater expansion in US poultry production by an additional 173,000 to 193,000 mt. Because of the jointness in poultry production, more US low-value poultry is produced and therefore the price increase is smaller when all trade barriers are removed. With a lower low-value price, the US is able to also expand its low-value poultry exports by around 70,000 mt.

RUSSIAN BAN ON US LOW-VALUE POULTRY IMPORTS

Russia is a major market for US low-value poultry products, accounting for nearly one-third of all US low-value poultry exports in 1998. An import ban on US low-value poultry by Russia would reduce the demand for US low-value poultry products while increasing the demand for these products from US competitors. Consequently, the price of US low-value poultry falls while the prices of low-value poultry from Brazil and the EU increase. As shown in the last four columns of table 7, the US low-value poultry price decreases by $31 to $36 per mt, or 6.4% to 7.4%, compared to the base price. The

[17] Simultaneous removal of the tariff-rate quota and SPS barriers might also give China access to the EU market but exports from China are mostly labor-intensive processed products targeted at the Japanese market, so we did not include EU access by China in the reported model.

changes in Brazilian and EU low-value poultry prices depend on whether Brazil is assumed to export to Russia or not. Without access to the Russian market, the Brazilian price remains virtually unchanged and the EU price increases $87 to $101 per mt, or 14.5% to 16.8%. With access to the Russian market, the Brazilian low-value price increases $95 to $115 per mt while the EU low-value price increases $22 to $28 per mt. Because of this change in relative prices, the US increases its low-value exports to China and the ROWM. Increased US exports to these regions offset some of the loss of exports to Russia, yielding an overall reduction in US low-value exports of 220,000 mt to 266,000 mt (10.8% - 13.1%). The changes in US poultry production is much smaller, 63,000 mt to 112,000 mt (0.4% - 0.7%) because the lower price of low-value poultry products lead to increased domestic consumption.

Table 7—Model Results

		Remove Tariffs and TRQ				Remove All Barriers				Russian Ban on US Exports			
		Long-Run		Short-Run		Long-Run		Short-Run		Long-Run		Short-Run	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Variable	**Base**	**IT1[a]**	**AT1[b]**	**IT1[a]**	**AT1[b]**	**IT2[c]**	**AT2[d]**	**IT2[c]**	**AT2[d]**	**IT3[e]**	**AT3[f]**	**IT3[e]**	**AT3[f]**
Poultry Production							(millions mt)						
US	15.238	15.368	15.317	15.314	15.288	15.561	15.490	15.417	15.388	15.137	15.126	15.175	15.169
Brazil	4.969	5.272	5.470	5.101	5.172	5.202	5.397	5.067	5.138	4.963	5.153	4.965	5.065
ROWE	5.682	5.965	5.931	5.814	5.810	5.898	5.875	5.777	5.775	5.676	5.663	5.677	5.676
EU	8.893	8.567	8.528	8.716	8.701	8.521	8.489	8.685	8.671	9.011	8.922	8.982	8.918
China	11.349	10.989	10.970	11.186	11.182	10.982	10.963	11.174	11.170	11.333	11.308	11.339	11.336
Japan	1.212	1.173	1.167	1.198	1.197	1.171	1.165	1.196	1.195	1.209	1.203	1.210	1.209
Russia	0.690	0.663	0.656	0.673	0.670	0.663	0.656	0.673	0.670	0.749	0.716	0.726	0.707
ROWM	14.411	14.469	14.415	14.448	14.422	14.465	14.413	14.446	14.419	14.398	14.377	14.402	14.392
Total	62.444	62.466	62.454	62.451	62.441	62.460	62.449	62.435	62.426	62.474	62.469	62.477	62.471
HV Poultry Prices							($1,000 mt)						
US	1.950	1.915	1.928	1.935	1.940	1.925	1.937	1.970	1.974	1.978	1.981	1.962	1.963
Brazil	1.850	1.883	1.826	1.960	1.946	1.870	1.815	1.925	1.912	1.855	1.772	1.851	1.828
ROWE	1.800	1.829	1.823	1.896	1.893	1.817	1.814	1.863	1.862	1.805	1.800	1.801	1.799
EU	2.900	2.823	2.834	2.721	2.723	2.819	2.830	2.697	2.700	2.823	2.881	2.870	2.892
China	1.750	1.832	1.829	1.792	1.790	1.831	1.829	1.785	1.784	1.754	1.749	1.751	1.749
Japan	2.200	2.160	2.158	2.134	2.133	2.158	2.156	2.124	2.123	2.207	2.201	2.203	2.199
Russia	2.205	2.269	2.287	2.156	2.144	2.271	2.288	2.155	2.144	2.067	2.143	2.296	2.251
ROWM	2.000	1.991	2.001	2.002	2.003	1.992	2.000	2.001	2.002	2.003	2.005	2.000	2.000
LV Poultry Prices													
US	0.485	0.524	0.509	0.524	0.511	0.521	0.506	0.522	0.509	0.454	0.451	0.453	0.449
Brazil	0.545	0.559	0.634	0.581	0.663	0.565	0.638	0.582	0.664	0.541	0.640	0.540	0.660
ROWE	0.600	0.614	0.617	0.636	0.635	0.620	0.621	0.637	0.636	0.596	0.598	0.595	0.596
EU	0.600	0.651	0.637	0.639	0.626	0.652	0.639	0.639	0.626	0.687	0.622	0.701	0.628
China	1.100	1.000	1.002	0.976	0.976	1.001	1.002	0.977	0.976	1.095	1.098	1.093	1.094
Japan	0.750	0.771	0.770	0.749	0.745	0.772	0.771	0.749	0.745	0.742	0.745	0.740	0.739
Russia	0.925	0.836	0.812	0.823	0.801	0.834	0.811	0.822	0.801	1.116	1.011	1.162	1.035
ROWM	0.800	0.811	0.800	0.813	0.801	0.810	0.800	0.812	0.801	0.796	0.794	0.796	0.792

Table 7—continued

							(millions mt)						
Total HV Exports													
US	0.000	0.000	0.000	0.000	0.000	0.111	0.099	0.098	0.095	0.000	0.000	0.000	0.000
Brazil	0.157	0.315	0.374	0.250	0.259	0.274	0.333	0.221	0.231	0.157	0.194	0.157	0.166
ROWE	0.187	0.333	0.313	0.273	0.270	0.293	0.280	0.243	0.241	0.187	0.178	0.187	0.185
China	0.247	0.227	0.213	0.292	0.289	0.221	0.209	0.279	0.276	0.247	0.228	0.247	0.242
Total	0.591	0.875	0.901	0.814	0.818	0.788	0.822	0.742	0.748	0.591	0.600	0.591	0.593
Total LV Exports													
US	2.038	2.320	2.213	2.282	2.200	2.393	2.281	2.308	2.227	1.797	1.772	1.818	1.793
Brazil	0.136	0.303	0.541	0.235	0.402	0.282	0.513	0.230	0.395	0.123	0.406	0.124	0.374
ROWE	0.126	0.281	0.272	0.219	0.217	0.263	0.256	0.215	0.213	0.114	0.113	0.114	0.115
EU	0.576	0.598	0.540	0.673	0.630	0.581	0.528	0.667	0.624	0.890	0.658	0.893	0.670
Total	2.874	3.502	3.566	3.409	3.449	3.519	3.579	3.419	3.458	2.924	2.949	2.949	2.953
Total HV Imports													
EU	0.105	0.362	0.379	0.308	0.311	0.383	0.395	0.330	0.332	0.105	0.105	0.105	0.105
Japan	0.385	0.420	0.424	0.413	0.413	0.422	0.426	0.415	0.416	0.385	0.389	0.385	0.386
ROWM	0.101	0.093	0.098	0.093	0.094	0.094	0.099	0.095	0.095	0.100	0.106	0.101	0.102
Total	0.591	0.875	0.901	0.814	0.818	0.900	0.920	0.840	0.843	0.591	0.600	0.591	0.593
Total LV Imports													
China	0.891	1.537	1.564	1.454	1.481	1.542	1.572	1.458	1.486	0.945	0.954	0.945	0.951
Japan	0.076	0.087	0.091	0.083	0.086	0.088	0.092	0.083	0.086	0.083	0.084	0.083	0.084
Russia	0.827	0.893	0.876	0.876	0.857	0.897	0.879	0.877	0.859	0.751	0.754	0.774	0.762
ROWM	1.081	0.985	1.034	0.996	1.025	0.992	1.036	1.000	1.028	1.146	1.157	1.148	1.156
Total	2.874	3.502	3.566	3.409	3.449	3.519	3.579	3.419	3.458	2.924	2.949	2.949	2.953

[a] IT1: Initial Trade, maintains bilateral trade patterns from base case.
[b] AT1: Augmented Trade, allows Brazil to export low-value poultry products to Russia and ROWM.
[c] IT2: Initial Trade, maintains bilateral trade patterns from base case but removal of barriers opens EU market to US exports.
[d] AT2: Augmented Trade, allows US entry into EU and Brazil to export low-value poultry products to Russia and ROWM.
[e] IT3: Initial Trade, maintains bilateral trade patterns from base case but eliminates US access to Russian market.
[f] AT3: Augmented Trade, eliminates US access but allows Brazil to export low-value poultry products to Russia.

4. SUMMARY AND CONCLUSIONS

This article has utilized a competitive partial-equilibrium spatial model with heterogeneous goods to examine the effects of non-technical and sanitary barriers that impede trade among five countries and the EU, which account for the majority of poultry trade, and two composite (exporting and importing) regions. The model draws a key distinction between high- and low-value poultry products, which are jointly produced but have distinct patterns of trade among the eight countries and regions in the model. On the demand side, we specify a four-level nested CES system in which imported poultry products in the high- and low-value categories compete with the similar goods produced domestically. Calibrating the model under the assumption that imports by a region would be consumed in equal amounts if all import prices were the same, we replicate observed trade flows, and derive import and domestic prices consistent with the benchmark data.

Our simulation results suggest that non-technical barriers to trade among the eight countries and regions have significant effects on world markets. Under our long-run elasticities, global trade would expand by more than 25% if non-technical trade barriers were removed by the major importers. Conversely, removal of only sanitary barriers opens few trade opportunities. Thus at the level of aggregation of our model, sanitary barriers alone would seem not to warrant as much consternation as they have provoked in poultry trade. But removing non-technical and sanitary barriers simultaneously creates additional trade opportunities compared to only removing non-technical barriers; in our case, primarily from the additional access the US gains to the EU market. The effects on production, consumption, and trade among countries thus differ under these two liberalization scenarios. Similar results would likely hold for other, more disaggregated bilateral trade disputes that have arisen over application of sanitary barriers precluding trade that otherwise would take place.

Our disaggregated results for high- and low-value poultry products also yield insights about the effects of trade policies on poultry markets. For the US, for example, with removal of non-technical trade barriers, expansion of poultry production to meet increased export demand for low-value products pushes down the domestic price of high-value products, whereas prices of high- and low-value products increase in Brazil. Production falls in the major importing regions with removal of trade barriers, but again the joint production of high- and low-value poultry, as well as increased trade flows, determine the effects on specific prices (and marketed quantities) within each country. When Brazil is assumed to enter Russia and the aggregated poultry-importing region as new markets, effects on production and exports resulting from trade policy reform are reduced for the US and EU, and their exports are partly diverted to China. Similarly, if US products are excluded from Russia, as has happened several times based on ostensible sanitary concerns, arbitrage opportunities partially ease the impact on the US poultry sector. These arbitrage effects are often overlooked in assessments of specific bilateral trade disputes, especially those involving sanitary issues. Our results show that these market arbitrage possibilities matter. They also show that both non-technical and sanitary barriers matter to world poultry markets.

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