
**Global Trade Analysis Project**
https://www.gtap.agecon.purdue.edu/

This paper is from the
GTAP Annual Conference on Global Economic Analysis
https://www.gtap.agecon.purdue.edu/events/conferences/default.asp

# Birds in a Coop: Looking at the Regional Broiler Market

*D. L. Salin, W. F. Hahn, and A. Somwaru*[1]

**Paper to be presented at the 6th Annual Conference on Global Economic Analysis**
**June 12-14, 2003. Scheveningen, The Hague, The Netherlands**

[1] D.L. Salin is an Agricultural Economist, Economic Research Service-U.S. Department of Agriculture, W.F. Hahn is an Agricultural Economist, Economic Research Service- U.S. Department of Agriculture, and A. Somwaru is a Senior Economist, Economic Research Service- U.S. Department of Agriculture.

## Introduction

The Doha Round provides an opportunity to fundamentally reform the three pillars of agricultural trade. The agreement calls for an increase in market access and reduction or elimination of export subsidies and domestic support. Sanitary and phytosanitary standards (SPS) have continued to emerge. Exporting countries are concerned that SPS measures designed to protect animal, plant, and human health might be used to shield domestic industry from foreign competition. This paper attempts to analyze the economic impact of changes in North America sanitary requirements on America's broiler production and trade flows. The results offer insights and understanding as to what degree trade barriers, such as SPS measures and safeguards, might become substitutes of the three pillars in the North America poultry industry. This is crucial because government policies could alter and unite the North America market, leading to regional supply response replacing individual country responses.

SPS measures affect both the direction of trade and its magnitude. Countries concerned about food safety and animal diseases have instituted sanitary regulations to safeguard their food supply. However, animal production systems are dynamic, evolving over time in response to technological, economic, and market conditions. Consequently, a country's disease status can change, thereby affecting production, consumption, trade flows, and trade strategies. Arbitrary or discriminatory application of SPS measures can protect domestic meat markets from foreign competition. Therefore, it is crucial to understand the sanitary regulations governing poultry trade in order to comprehend this unique situation and to assess the economic impacts of potential changes in trade flows.

In January 1995, the World Trade Organization (WTO) implemented the application of the SPS Agreement with the purpose of minimizing the negative effects of unjustified health barriers on international trade. Under this agreement, codes were established to prevent the introduction of infectious agents and diseases into importing countries through trade of animals or animal products (OIE 2003). Although the SPS Agreement requires transparency and science-based regulations, it does not require the adoption of international standards (*harmonization*). In addition, nations have accepted the concept of "regionalization", thereby recognizing disease-free regions or zones within a country. This would allow exports from distinct regions within a country that present evidence of the absence or low incidence of pests and diseases (Roberts 1998a, Roberts 1998b, Salin et al. 2002, Kassum and Morgan 2002).

Lack of homogeneous sanitary standards across countries can seriously impede trade of poultry and animal products. Extensive adoption of international standards can yield large benefits to exporters (Orden et al. 2002). Consumers in importing countries may benefit as well from the elimination of regulatory heterogeneity through lower prices and increased product choices while maintaining an appropriate level of protection for animal and human health. This paper aims to quantify these benefits in the North America poultry industry. The paper is organized as follows. Section 1 presents an overview of the global poultry sanitary measures. Section 2 describes the broiler world market and

trade. Section 3 provides the analytical approach. Section 4 discusses model results. Finally, Section 5 presents the study conclusion.

## North American Poultry Industry and Sanitary Measures

Exotic Newcastle disease (END) and highly pathogenic avian influenza (HPAI), included in List A of the International Organization for Epizootics (OIE) classification of transmissible poultry diseases, are two highly infections diseases that restrict poultry trade (Table 1). Countries in which END exists can export only processed poultry meat but not fresh, chilled, or frozen poultry (Salin et al. 2002, FSIS 2003). Currently, the U.S. Animal and Plant Health Inspection Service (APHIS) considers END to exist in all but 16 regions of the world (table 2). In addition, APHIS recognizes two Mexican states, Sinaloa and Sonora, as having a low risk of END transmission.

On October 1, 2002, an outbreak of END was confirmed in California. This outbreak originally occurred in small backyard flocks and spread later to commercial egg laying type bird operations. Subsequently, END has been confirmed in noncommercial flocks in Nevada, Arizona, and parts of Texas and New Mexico. Since the beginning of the outbreak, 3.5 million birds have been killed (APHIS, 2003). This represents slightly over 1 percent of the total U.S. commercial egg laying hen population. The END outbreak has not affected the U.S. commercial broiler industry

However, changes in END status of potential large poultry suppliers could have a major impact on world poultry exports, especially for high value white meat. Since 1999, Mexico, the world's fifth largest broiler producer, (fig. 1) has intensified efforts to gain more END free states and eligibility to export fresh, chilled, and frozen poultry to the U.S. (Salin et al., 2002). Effective August 1, 2002, Canada recognized Brazil's poultry inspection system. In addition, eight[2] Brazilian states were recognized free of END by the Canadian Food Inspection Agency (CFIA 2002). Brazil is the second largest broiler producer, consumer, and exporter in the world (fig. 1, 2, and 3).

Understanding the economic impact of changes in sanitary requirements on poultry trade in North America is crucial because SPS measures could prevent the emergence of an integrated North America poultry market, at least in terms of common supply response. In 2001, the *NAFTA Partnership* association was formed. This is a voluntary association consisting of U.S. and Mexican poultry interests working together to make a smooth transition after January 1, 2003, when by law tariffs and quotas were abolished for U.S. poultry exports to Mexico. The Partnership consists of the Mexican Poultry Union, USA Poultry & Egg Export Council, National Chicken Council, National Turkey Federation, and United Egg Producers. Canada is on the verge of being invited to join the *NAFTA Partnership* association (Wright, 2002: 22-24).

[2] Mato Grosso do Sul, Minas Gerais, São Paulo, Paraná, Santa Catarina, Rio Grande do Sul, Goiás, Mato Grosso or the Federal District of Brazil.

Despite interests by both parties in working together, tensions nevertheless exist between the U.S. and Mexico, which has been compounded by the recent END outbreak in the United States. Mexican poultry officials have for some time argue that Mexican medium and small producers cannot compete with the U.S. because U.S. producers have access to low-priced feed resulting from American feed grain government programs (Coleman and Payne, 2003). On January 22, 2003, the Mexican government imposed a provisional (six months) bilateral safeguard measure on imported U.S. broiler leg quarters (FAS, 2003). The safeguard established a minimum Tariff Rate Quota (TRQ) of 50,000 MT and 98.8 percent duty on U.S. broiler leg quarters. The purpose of the safeguard is to maintain the degree of protection equivalent to the protections that were in place in 2001.

## Broiler Markets and Trade Overview

Poultry products are produced and consumed worldwide due to their short production cycle, cooking versatility, low fat content, and relatively low prices compared with beef and pork. Broiler markets are highly concentrated in production and international broiler trade is dominated by a few countries (Rogowsky, 1998). In 2002, world broiler production totaled about 54 million tons, in ready to cook (RTC) equivalent form. The United States is the world's largest producer followed by China, Brazil, European Union (EU), and Mexico. These five countries account for more than 70 percent of the world's production (fig. 1). Broiler production has become highly concentrated, especially in the United States, Brazil, Mexico, and Thailand, where a few large firms account for most of the production (Orden et al., 2002, UNA, 2002). The United States is the world's top broiler consuming country, accounting for about one-quarter of global consumption, followed by China, EU, and Brazil. These four countries account for 65 percent of the world's broiler consumption (fig. 2). The United States and Brazil dominate international broiler trade globally. These two countries account for more than two-thirds of the world's broiler exports (fig. 3). Russia, Japan, and China are the world's largest importers accounting for more than half of world's broiler imports, followed by the EU, Saudi Arabia, Mexico, and Hong Kong. These seven countries account for 85 percent of total world broiler imports (fig. 4).

In the North American region, broiler production totaled 17.6 million tons in 2002. This represents 32 percent of total world broiler production (fig. 1). This region consumed 15.7 million tons of broilers in 2002, comprising 30 percent of total world broiler consumption (fig. 2). The United States is the largest broiler producer and consumer worldwide. In addition, it is the only net broiler exporting country in this region, accounting for 38 percent of total world exports (fig. 3). Mexico is the fifth largest world broiler producer and consumer country. Mexico and Canada are among the top 10 broiler importing countries, accounting for about 8 percent of the world's broiler imports (fig. 4).

International poultry trade flows are influenced by comparative advantage in production, differences in consumer preferences as well as policy decisions (Orden et al., 2002, Salin et al., 2002). Tariff Rate Quotas (TRQS) as well as sanitary restrictions are the major barriers to poultry trade.

This study:

1. Measures how broiler prices, production, and trade will change (over the intermediate/long run) as a result of allowing Mexico's and Brazil's END-free regions to ship broilers to the U.S. and Canada.
2. Analyzes the impact on broiler markets and trade in the Western Hemisphere as sanitary regulations are satisfied and the region becomes END free.
3. Measures the sensitivity of these results to alternative estimates of supply and demand elasticities.

## Analytical Approach

We use our *Broiler-Trade* model, with its product-market specification, to evaluate the potential effects of allowing broilers from relatively low-risk Mexican and Brazilian states to be shipped to the United States and Canada. The model includes the following countries: the U.S., Canada, Mexico, and Brazil. These countries have full supply and demand specifications that allow the evaluation of the potential impacts of low-risk END broilers shipments to U.S. and Canadian markets. In addition, four regions are modeled as excess demand areas. These regions represent the Caribbean, Central America, the rest of South America, and the Eastern Hemisphere. The model captures the production structure and marketing of the various trade patterns and it incorporates different SPS measures affecting Canada, U.S., Mexico, and Brazil broiler and broiler-product trade.

The model is a mathematical programming (MP) model, with a structure similar to the North American Trade Model for Animal Products (NATMAP) (Hahn, 1993). The use of MP as a method for modeling equilibrium in competitive markets dates back to 1952 (Samuelson). The Broiler-Trade model disregards other animal products from NATMAP but expands the broiler section, and "regionalizes" the countries in North America. In NATMAP, broiler production was modeled as whole-bird production. In the Broiler-Trade model broiler production is differentiated into whole broilers, white meat, dark meat, and other broiler products, including backs, necks, and mechanically deboned meat (MDM).

The model looks at broiler and broiler cut supply and demand at the wholesale level. We model the wholesale level, because this is the level at which trade in broiler and broiler products occur. The NATMAP-type structure uses a consumer-level demand specification. Wohlgenant and Haidacher show that when markets are competitive, derived demands have the same properties as consumer demands provided one adds in the demand for marketing inputs (Wohlgenant and Haidacher, 1989). Our model, rather than modeling broiler demand, implicitly includes broiler and broiler marketing inputs. We maintain the typical, partial equilibrium assumption that changes in broiler prices do not cause changes in other product prices. If the prices of all other goods are fixed, then we can aggregate their expenditures into a single good, using Hicksian aggregation as suggested by Lewbel (Lewbel, 1996).

The model uses two types of broilers that produce eight types of broiler products. The two broiler types are (1) broilers raised for the whole broiler and (2) broiler raised for cuts/parts market. There are five basic products and three value-added products. One of the final products is a whole broiler. Parts-type broilers produce four kinds of broiler parts in fixed proportions. These broiler parts are white meat (breasts), dark meat (legs, thighs), other cuts (wings, backs, necks) and MDM produced in naturally fixed proportion. In the United States, the high demand for white meat exerts an upward pressure on white meat prices relatively to dark meat while low dark-meat prices in the United States fuels much of its broiler exports.

In addition to these five commodity products, the model has three value-added products. Value is added to whole broilers, white meat, and dark meat. We included whole broilers in the value-added category to account for the importance of rotisserie broilers in Mexico. Most of the "other" parts market is exclusively devoted to either value-added or commodity products. In the United States, backs and necks are low-value products while wings are part of value-added products. All MDM is used in further processing and constitutes an important export commodity. Value is added to MDM after it is traded, not before.

Policies are modeled either as restrictions on the model or as cost factors. For example, tariffs and other import fees increase the costs of broiler trade. Sanitary barriers are treated as absolute restrictions preventing broiler-product exports from Mexico and Brazil to the United States and Canada. Canada's supply controls are modeled as a restriction on total production. Because Canada's over-quota tariff rates on broiler imports are so high, the Canadian broiler quota is treated as a constraint on total broiler imports.

Value-added white and dark meat includes categories of products such as boneless, skinless, and processed products for the restaurant trade. Our value-added sector focuses on those products for the restaurant trade. One of the innovative features of this model is our treatment of value-added products. We have developed a means of incorporating endogenous levels of value-added in domestic and international trade. Our theory of endogenous, product differentiation is outlined below.

**Product Differentiation, Value-added, and Trade**

It is common for countries to engage in significant bilateral trade that involves trade in the "same" commodity. Economic modeling of "same" commodities bilateral trade is problematic. It can only be accomplished by the use of on Armington specification (Alston et al. 1990) which is based on the hypothesis that one country's products are imperfect substitutes for another's or by introducing regions within nations, internal transportation costs, etc.

The *differentiated-product* case helps explain bilateral trade. One problem with the Armington approach is that it does not explain how products become differentiated. This paper presents an explanation for the source of product differentiation and that is differences in value-added to a "generic" commodity. Our explanation of the theory will

to focus on the single-good, single country case. The model features multiple countries and multiple, value-added products. We consider a *value-added product* a combination of *ingredients* and *services*. By ingredients, we mean the physical product. In this case, ingredients are whole chickens and chicken cuts. Services are largely confined to processing. Examples of services in this case include boning and skinning, packaging, and further processing. *Portion control*, the production of standard-sized portions for the restaurant trade, is another example of services applied to an ingredient.

Adding value to basic ingredients via the use of service allows a country to export services. The exported good can then be classified based on its main ingredient. A country with low ingredient costs and high costs of services could have bilateral trade with a country with high ingredient costs and low value-added costs.

Our programming model uses simple types of value-added products. Our discussion will focus on the simple case captured in the model, but we will note obvious extensions. One simplifying assumption that we make is to define a value-added product with only one ingredient and one service. There will be a fixed proportion relationship between the ingredient, the service and the value-added product. Doubling the production of the value added product requires a doubling of the ingredients and service. Two obvious extensions to our basic model would be to (1) allow for multiple ingredients and services and (2) more complex production relationships.

The amount of service added to the ingredient is fixed in our model. Our model resembles a supply-side version of Lancaster's model of the demand for characteristics (Lancaster 1966). In this approach, the goods consumers buy are modeled as bundles of characteristics. In our model, the value-added product is literally a bundle of characteristics. If we were to model consumer demand using characteristic demand, it would be possible to make the desired amount of service added to the ingredient endogenous. The amount of "service" added to each product varies by product and country. We would normally expect that the demand for services would be income elastic. The United States and Canada are likely to demand more highly-processed products than Mexico or Brazil.

Our theory of product differentiation also draws on household production theory or the theory of "boundary of the firm." The basic problem for the consumer or firm is the same: the consumer or firm desires some value-added product for consumption or sale. Part of the economic agent's problem is to decide how much of the value-added will be performed by the agent and how much is going to be acquired from the market. There are two extreme cases. In one case, the economic agent buys the raw commodity and carries out all the value-added process. In the other case, the economic agent buys the desired final value-added product. However, we can allow for a range of options between the two extreme cases by allowing the agent to buy partially processed products. In our two-characteristic case, the partially processed products are a combination of raw commodity and purchased value-added. The partially processed product is going to be treated as a bundle of characteristics, just as in the characteristic model of demand.

Since we have assumed a fixed proportions relationship between ingredients and services, we can focus initially on the per-unit relationship between embedded bought service and self-produced service. The partially processed product will be defined so that one unit of it has enough ingredients to make one unit of the final product. Suppose "*b*" stands for the value-added in each unit of the partially processed product, that "*m*" stands for the per-unit value-added made by the firm or consumer, and that "*v*" is the per-unit value-added target.

Our model hypothesizes a production function that relates v, b, and m as follows:

**(1)** $v = f(b, m)$

A general form as in (1) allows commodities to be either perfect or imperfect substitutes. The programming model uses a constant-elasticity-of-substitution (CES) function for (1). Our assumptions about how the final product is produced allow us to separate the supply of ingredients from the supply of services. In a competitive equilibrium, the optimal amount of "bought" versus "made" service is going to be determined by equating the marginal value product (MVP) of bought services to that of made services. The MVP of "made" service in the consumer demand for partially processed products reflects the currency-equivalent value of marginal utility. The level of embedded service in the partially processed product is endogenous. The price of the partially processed product ($p_p$) is going to be the marginal cost of the ingredient ($p_i$) plus the marginal cost of the embedded service ($p_b$) times the amount of embedded service:

**(2)** $p_p = p_i + b * p_b$

Generally, higher-income consumers buy more services and more products with embedded, value-added services. Differing household costs of "do-it-yourself" explains why we observe the same basic ingredients with different levels of services attached being marketed to final consumers. As noted above, our programming model simplifies reality by assuming only a limited number of value-added products. We allow the amount of desired service to vary across countries. In our approach we include products at the wholesale level, not at the retail end-user consumption products. Since we expect less diversity in firm technology than in consumer's preferences, limiting the range of value-added products at this wholesale level is likely to be less restrictive.

The model treats each country's broiler as a perfect substitute for every other country's broiler products instead of as differentiated products. As END and food safety requirements prevent poultry from Brazil or Mexico from being shipped to the U.S. or Canada, estimating the substitutability of Brazilian or Mexican broilers with U.S. or Canadian broilers in the region is not possible. The perfect-substitutability assumption allows for upper boundary estimates of trade and price effects of sanitary barrier changes. Further, in the case of broiler trade, differences in consumer tastes and prices for broiler cuts determine a large part of the trade. For example, dark meat prices are relatively low in the United States and Canada compared to other countries. By accounting for consumer taste, we can differentiate a country's imports and exports.

**Predicting Broiler Market Impacts: Model Assumptions and Results**

All scenarios were based on the following assumptions:

(1) Total broiler production, consumption, and the trade patterns for the four countries are based on 2002 estimates. Production is calculated on a ready-to-cook (RTC) basis. However, trade and consumption are measured on a product-weight basis. Value-added products lose bone and skin in processing. The trade and consumption numbers are based on the weight of the product, not on the weight of the broiler underlying the product. At present, END has not been detected in any commercial broiler flocks. Therefore, we assume that U.S. broiler production is END free. Seventeen percent of U.S. broiler production is sold as whole birds (Parsons, 2003). This ratio was also used for Canada. Fifty percent of Mexican and Brazilian broiler production is whole birds. Although Mexican broiler processors market 80 percent of their production as whole birds (UNA, 2002), this doesn't imply that consumers usually buy whole birds. Consumers often buy broiler parts/cuts at supermarkets, public markets, and butcher shops where the cut-up operation takes place (Salin and Hahn, 2003). Consumer demand for parts determines Mexico's demand for imported broiler parts. Our use of 50 percent reflects a compromise between plant-level production and final consumption.

(2) U.S and Canadian consumers demand the same amount of processing in value-added broiler cuts and have similar broiler value-added costs. We assumed that U.S. and Canadian value-added broiler cuts have 4 times more embedded services than Mexican and Brazilian cuts due to higher income consumers in these countries. Mexico's cost of adding value is assumed to be 30 percent of the U.S. cost. Salin and Hahn (2003) indicate that typical Mexican wholesale-retail markup on broiler is about 30 percent, as opposed to 100 percent in the United States. Brazil's costs of value-added are the same as in Mexico's. The difference between U.S. and Canadian value-added and "generic" cuts is 12 times more than the Mexican or Brazilian difference because consumers in these two countries demand 4 times more processing while the processing costs is assumed to be 3 times higher. We also assumed that 75 percent of the value-added of processing broiler parts in the United States and Canada is performed at the processor level, while the remaining 25 percent of the value added is completed by the final seller of the product. We reversed these percentages for Mexico because Salin's and Hahn's report indicates that most broiler processing in Mexico occurs closer to the final users. We also assume that Brazil's "bought" versus "made" shares of embedded services are the same as Mexico's.

(3) The "consumer" sector is actually a combination of consumers and firms that purchase wholesale broiler products for sale to the final consumers. The "consumer" benefits are the sum of firms' and consumers' surplus.

(4) Mexico imposes a 5 percent ad-valorem tariff on broilers. The U.S. tariff on broilers varies by cuts and source. Canadian and Mexican broilers can enter the U.S. duty-

free. For broilers imported from Brazil, U.S. tariff rate is at 4.4 cents per kilogram or 2 cents per pound. Brazilian import tariffs are irrelevant to the model, as Brazil does not import broiler in the baseline or any of the alternative scenarios.

(5) Currently in Mexico only two states, Sinaloa and Sonora, are recognized as being relatively low-risk of END transmission by APHIS. Sinaloa and Sonora account for 4 percent of total Mexican poultry production (Salin et al. 2002). We assume that eventually additional states in Mexico will be recognized as free of END.

(6) Canada has recognized Mato Grosso do Sul, Minas Gerais, São Paulo, Paraná, Santa Catarina, Rio Grande do Sul, Goiás, Mato Grosso or the Federal District of Brazil as END free. We assume that the U.S. in the future will likewise recognize these states as END free. These Brazilian states account for about 72 percent of total Brazil poultry production. In addition, we assume that at some point in time Mexico and Brazil are certified to export fresh, chilled, or frozen broiler products to the United States and Canada.

**Scenarios**

To determine the economic impact of allowing Mexico and Brazil to export fresh, chilled or frozen broiler to the United States and Canada, four scenarios were developed:

- Scenario 1: the baseline, representing current sanitary policies, which prevent exports from Mexico and/or Brazil to the U.S. and Canada.
- Scenario 2: 4 percent of total Mexican production is exported to the U.S., Canada, and rest of the world -- this quantity is produced in Sinaloa and Sonora states. These states are recognized as relatively low risk of END transmission by APHIS. 50 percent of total Brazilian production is exported. This quantity represents the production in the states of Minas Gerais, São Paulo, Santa Catarina, and Rio Grande do Sul. These states represent about 53 percent of total Brazilian broiler production (ABEF, 2001) and are recognized by CFIA as free of END transmission.
- Scenario 3: 15 percent of total Mexican production is exported - - this quantity is produced in Sinaloa, Sonora and one of the following states as they are recognized relatively low risk of END transmission: Jalisco, Veracruz, Coahuila, Querétaro Puebla, Nuevo León, Aguascalientes, and Estado de México (UNA, 2002). Each of these states accounts for between 6 to 13 percent of national broiler production. 70 percent of total Brazilian production is exported - - this quantity is produced in Minas Gerais, São Paulo, Santa Catarina, and Rio Grande do Sul, and Paraná states. These states represent 72 percent of Brazilian total broiler production.
- Scenario 4: 100 percent of total Mexican and Brazilian broiler production is exported. This quantity represents 100 percent END free regions in Brazil and Mexico. All scenarios reflect changes in sanitary policies compared with the Baseline. In addition, Canada maintains its import quota on broiler and its domestic production quota.

## Empirical Results

Low labor costs and relatively low white meat prices give Mexico and Brazil a competitive advantage in supplying value-added white meat to the United States and Canada. Exports from Mexico and Brazil to the United States and Canada grow as more regions within these two countries are recognized as free of END (table 3). U.S. production contracts as Mexican and Brazilian production expands. The largest increase in Brazilian production occurs in the alternative where only 4 percent of Mexican production is eligible to be exported to the north. As its END-free area grows, Mexico's advantageous location makes it relatively more competitive.

Total U.S. and Canadian broiler consumption declines on a product-weight basis as more of the two Southern countries become free of END (table 4). This decline in product-weight consumption is due to the shift from "generic" to value-added products. Canada's very small decline in broiler consumption on a product-weight basis is due largely to value-added cuts having less bone and skin than "generic" products. In Canada, total consumption is mostly determined by production and import quotas. A small part of the decline in broiler consumption in the United States is due to value-added cuts losing weight in processing. The larger part of the decline in product-weight consumption in the United States is due to a substitution from low-cost "generic" product to higher-cost value-added product. U.S. consumers allocate more of their income on value-added broiler cuts than on "generic" cuts and thus, consumption and spending on "service" increases while that on generic product decreases.

Sanitary reforms have small impacts on the prices of broiler and broiler cuts (table 5 and 6). The prices of whole broilers and white meat decline slightly in the two Northern-most countries and rise in Mexico and Brazil. Higher white meat prices in the United States and Canada relative to Mexico and Brazil are transmitted to Mexico and Brazil, increasing the total value of broilers in these countries. In response to higher prices, Mexico and Brazil expand their production.

U.S. exports to Canada are displaced by Mexican and Brazilian exports (table 7). This displacement is driven by their advantage in supplying lower-cost value-added products. U.S. exports to Mexico shrink as extra production of value-added white meat for the Northern markets leads to increased domestic supplies of dark meat and MDM. Aggregate Brazilian exports increase but exports to the rest of the world decline compared with the Baseline for two reasons: (1) The increase in Brazilian prices makes Brazil less competitive in the world market; (2) Large portions of exports are diverted to the United States; (3) Other exporting countries would be expected to increase their market share. As more Brazilian regions are recognized as low-risk of END transmission, the United States loses market share in the world market.

Table 8 captures how three groups of economic agents fare as Mexico and Brazil eliminate END. The three groups are the integrated broiler producers (broiler farming and slaughtering), further processors of broiler, and consumers of wholesale broiler. The net economic benefits do not include the costs of END control and eradication. The

economic benefits for integrated production and further processing are measured by the change in profits. The "consumer" sector is actually a combination of consumers and the firms that buy wholesale broiler products for sale to the final consumers. The "consumer" benefits are the sum of the change in firm and consumer surplus (see assumptions in the previous section).

U.S. and Canadian integrated broiler production and broiler processing sectors face lower earnings as Mexico and Brazil eradicate END, but U.S. and Canadian consumers gain. In the case of Canada, consumers' and producers' gains/losses depend on the supply and level of import quotas. The situation is reversed in Mexico and Brazil as their producers and processors gain while consumers lose because higher prices in the United States and Canada are transmitted to Mexico and Brazil. The net benefits in each country are positive. Each country's aggregate economy gains as Mexico and Brazil eradicate END as the increased benefits to the gaining sectors outweigh the losses to losing sectors.

## Conclusions

The United States and Brazil are the world's two largest broiler exporters. The END outbreak in the United States has not had any significant impact on U.S. exports since it has not affected the major broiler exporting states. The presence of END in certain regions in Brazil prevents shipment of Brazilian fresh, chilled, or frozen poultry meat to the United States. Mexico has a significant broiler industry, but also has END. Because of the Uruguay Round Agreement, the United States is committed to the regionalization of sanitary barriers. U.S. recognition of portions of Mexico or Brazil as free of END and acceptance of their poultry inspection systems could have a major impact on world broiler trade.

U.S. consumers have a stronger preference for white meat than Mexican and Brazilian consumers. This strong preference for white meat raises U.S. white meat prices and also helps keep dark meat prices low. Low dark-meat prices are one of the most important factors fueling U.S. exports. Coupling lower white meat prices with lower processing costs and elimination of END makes Mexico and Brazil competitive suppliers to the U.S. market. However, the model does not account for costs associated with the elimination of END in Mexico and Brazil.

Given price differentials and income levels, expansion of imports from the rest of the Western Hemisphere will tend to decrease U.S. broiler production. A large portion of world broiler trade is driven by subtle differences in countries' economic development and consumers' purchasing power. The model finds a long-run equilibrium under the assumption that the rest of the economy is not affected by changes in the broiler sector. Current trends in the Mexican and Brazilian economies as a whole are likely to reduce the estimated long-run impacts of sanitary barrier reforms. White meat is the more expensive cut in Mexico, and it is likely that the preference for white meat will grow along with Mexico's economic development. If economic growth in Mexico and Brazil accelerates, this is expected to lead to improved wages and more environmental

regulations, which in turn could decrease their relative competitiveness in the further processing of broiler cuts.

**References**


Associação Brasileira dos Pordutores e Exportadores de Frangos (ABEF), 2001.

Agriculture and Agri-Food Canada. November 11, 2002. Minister of Agriculture and Agri-food, Canada, <http://www.agr.gc.ca>.

Alston, Julian, Colin Carter, Richard Greeen, Daniel Pick. 1990. "Whither Armington Trade Models?" *American Journal of Agricultural Economics*. Vol. 72: 455-467.

Coleman Jonathan R., and Warren Payne. 2003. "Factors Affecting Trade in Mexican Imports of Poultry Meat From the United States". Office of Industries Working Paper, U.S. International Trade Commission.

Companhia Nacional de Abastecimiento (CONAB), Ministério da Agricultura, Pecuária e Abastecimiento, Brazil, <http://www.conab.gov.br >. November 26, 2002.

Hahn, William F. 1990. *North American Trade Model for Animal Products*, Technical Bulletin No. 1830, USDA Economic Research Service.

International Organization for Epizootics (OIE). March 29, 2003. Data on Animal Diseases, OIE Classification of Diseases. <http://www.oie.int/eng/normes/mcode/a_summry.htm>.

Kassum, Julian and Nancy Morgan. 2002. "The SPS Agreement: Livestock and Meat Trade. Draft Food and Agriculture Organization (FAO) Paper.

Lancaster, Kelvin J. May 1966. "Change and Innovation in the Technology of Consumption." *American Economic Review,* 56(2): 14-23.

Lewbel, Arthur. June 1996. "Aggregation without Separability: A Generalized Composite Commodity Theorem." *American Economic Review* 86(3): 524-543.

National Archives of Records Administration. January 1, 2003, *Code of Federal Regulations*, Title 1, Vol.9, Section 94.6 and 94.22.

Orden, David, Timothy Josling, and Donna Roberts. 2002. *Product Differentiation, Sanitary Barriers, and Arbitrage in World Poultry Markets*. Global Food Trade and Consumer Demand for Quality, Kluwer Academic/Plenum Publishers, New York.

Parson Richard. National Poultry Supervisor, Poultry Market News. USDA-Agricultural Marketing Service. Personal Communication on March 6, 2003.

Roberts, Donna. 1998a. *Preliminary Assessment of the Effects of the WTO Agreement on Sanitary and Phytosanitary Trade Regulations*, Journal of International Economic Law Oxford University Press 3(1): 377-405.

--1998b. *Implementation of the WTO Agreement on the Application of Sanitary and Phytosanitary Measures: The First Two Years*, International Agricultural Trade Research Consortium, University of Minnesota.

Rogowsky, Robert A. and Very Simpson. December 1998. *Industry and Trade Summary: Poultry*. U.S. International Trade Commission, Publication 3148.

Salin, Delmy, William H. Hahn and David J. Harvey. December 2002. *U.S.-Mexico Broiler Trade: A Bird's Eye View*. E-Outlook Report, ERS-USDA, LPD-M-102-01. <http://www.ers.usda.gov/publications/ldp/dec02/ldpm10201/DBGen.htm>.

Salin, Delmy and William H. Hahn. "Trip Report of the Mexican Broiler Marketing System." Unpublished paper, February 17, 2003.

Samuelson, Paul A. 1952. "Price Equilibrium and Linear Programming." *American Economic Review* Vol. 42, no. 1 pp: 283-303.

Secretaría de Agricultura, Ganadería y Desarrollo Rural, Pesca y Alimentación (SAGARPA)-Servicio de Información y Estadística Agroalimentaria y Pesquera (SIAP). September 2001. *Anuario Estadístico de la Producción Pecuaria de los Estados Unidos Mexicanos 2000*.

Unión Nacional de Avicultores (UNA) de Mexico. Abril 2002. *Compendio de Indicadores Económicos del Sector Avícola*.

USDA *Agricultural Baseline Projections to 2012*, Office of the Chief Economist, Staff Report WAOB-2003-1.

USDA Animal and Plant Health Inspection Service (APHIS). April 2003. Emergency Management Warning 87: "Exotic Newcastle Disease Confirmed in the United States". <http://aphisweb.aphis.usda.gov/lpa/issues/enc/emws/encdw87-03.html>.

USDA Foreign Agricultural Service (FAS). January 24, 2003. "Mexico Poultry and Products Provisional Safeguard on Chicken Leg Quarters." Gain Report Number: MX3012. Global Agricultural Information Network.

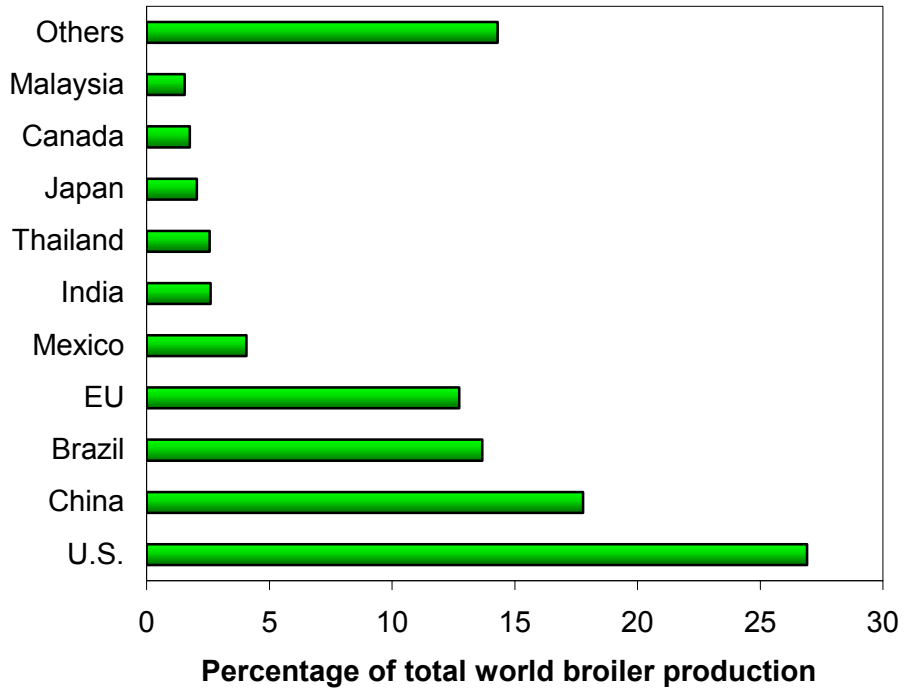
USDA Food Safety and Inspection Service (FSIS), Field Automation and Information Management Division. Personal Communication on March 6, 2003.

Wohlgenat, Michael K. and Richard C. Haidacher. December 1989. *Retail-toFarm Linkages for a Complete Demand System of Food Commodities.* Technical

Bulletin 177, United States Department of Agriculture Economic Research Service.

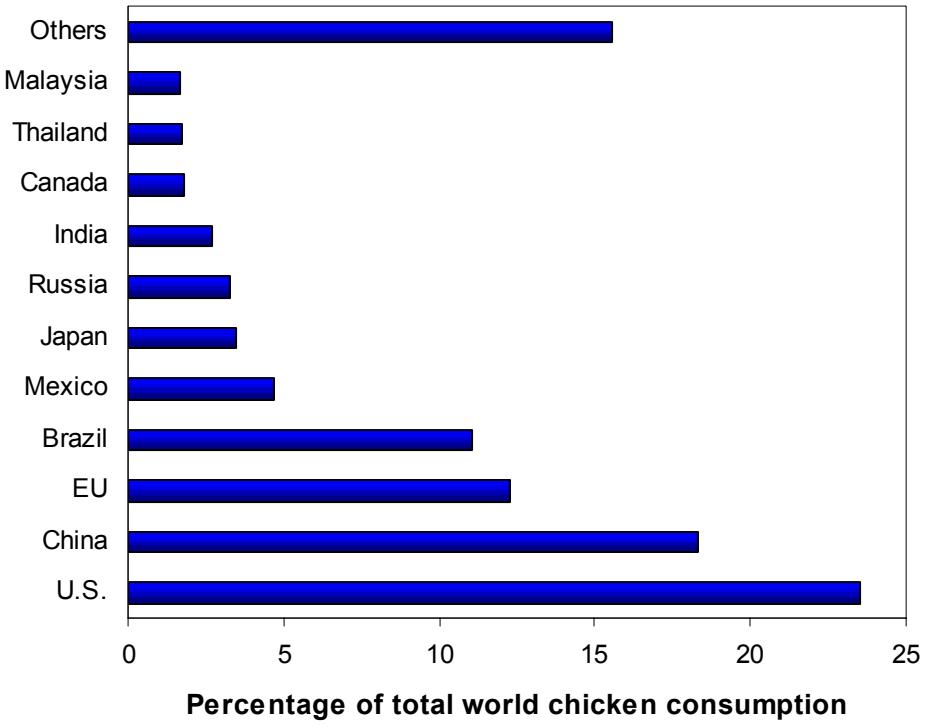
Wright Chris. August 2002. Mexico Nervous Ahead of NAFTA Deadline, *Poultry USA*, pp. 22-24.

**Figure 1 Top ten world broiler producing countries, 2002**



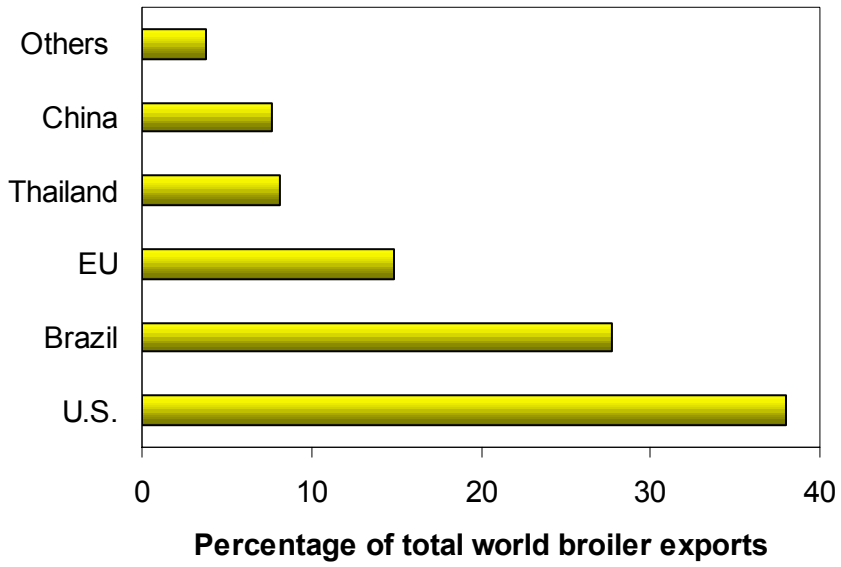

Source: USDA-Foreign Agricultural Service

**Figure 2 The U.S., China, and the EU accounted for more than half of world chicken consumption, 2002**



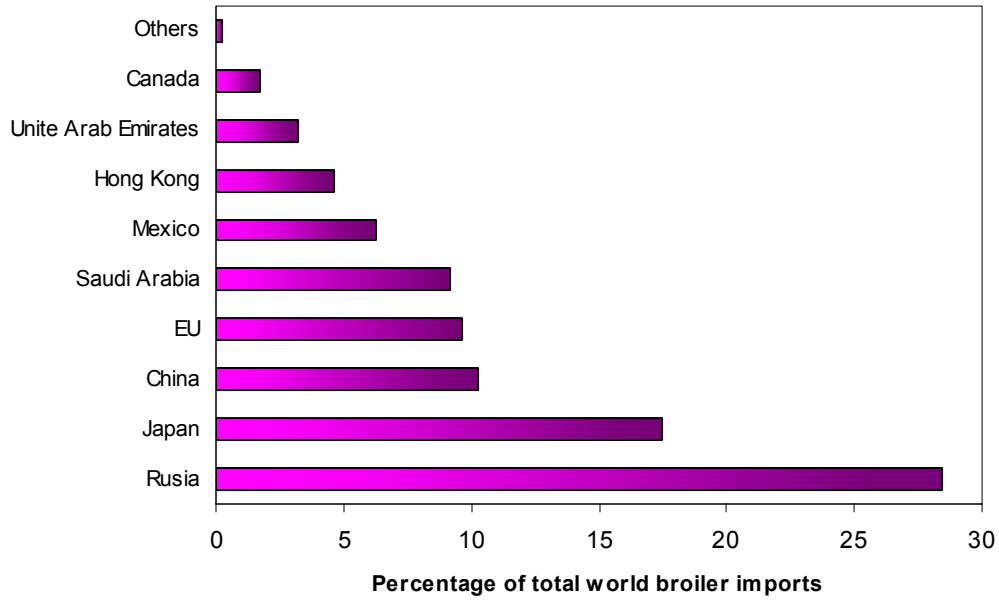

Source: USDA-Foreing Agricultural Service

**Figure 3 The U.S. and Brazil accounted for two thirds of total world broiler exports, 2002**




Source: USDA-Foreign Agricultural Service

**Figure 4 Rusia, Japan, and China accounted for more than half of world chicken imports, 2002**




Source: USDA-Foreign Agricultural Service

**Table 1—OIE Classification of Poultry Diseases, 2003**

| List A-major importance in the international trade of animals and animal products | List B-significant in the international trade of animals and animal products |
|---|---|
| Highly pathogenic avian influenza | Avian chlamydiosis |
| | Avian infectious bronchitis |
| Newcastle disease | Avian infectious laryngotracheitis |
| | Avian mycoplasmosis (M. gallisepticum) |
| | Avian tuberculosis |
| | Duck virus enteritis |
| | Duck virus hepatitis |
| | Fowl cholera |
| | Fowl pox |
| | Fowl typhoid |
| | Infectious bursal disease (Gumboro disease) |
| | Marek s disease |
| | Pullorum disease |

Source: International Organization for Epizootics (OIE). Data on Animal Diseases, OIE Classification of Diseases. <http://www.oie.int/eng/normes/mcode/a_summry.htm>. March 20, 2003.

**Table 2—Countries declared by APHIS to be free of exotic Newcastle disease (END)**

| Regions | Disease Free Regions |
|---|---|
| Europe | Finland, France, Great Britain (England, Scotland, Wales, and the Isle of Man), Greece, Iceland, Luxembourg, Republic of Ireland, Spain, Sweden, Switzerland. |
| Others | Australia, Fiji, New Zealand, Canada, Chile, Costa Rica. |

All other countries are considered to contain these pathogens

Source: National Archives of Records Administration, Code of Federal Regulations, Title 9, Vol. 1, Chapter 1, Section 94.6, January 1, 2003.

**Table 3—Sensitivity analysis: Predicted chicken production (RTC equivalent) with expansion of low-risk-of-END areas in Mexico and Brazil**

| Countries | Scenarios[1] | U.S.A. | Canada | Mexico | Brazil |
|---|---|---|---|---|---|
| | | ----------1,000 metric tons ---------- | | | |
| Baseline, 2002 | 1 | 14,467 | 945 | 2,188 | 7,355 |
| Mexico 4%, Brazil 50% | 2 | 13,855 | 945 | 2,261 | 7,835 |
| Mexico 15%, Brazil 70% | 3 | 13,813 | 945 | 2,345 | 7,802 |
| Mexico and Brazil 100% | 4 | 13,643 | 945 | 2,556 | 7,765 |

[1]The "Baseline" scenario represents current conditions under which Mexico and Brazil cannot ship fresh, chilled, or frozen poultry to the United States and Canada.
The percent scenarios are that portion of Mexican and Brazilian production occurring in relatively low-risk of END transmission states.

**Table 4—Sensitivity analysis: Predicted chicken consumption (wholesale product basis) with expansion of low-risk-of-END areas in Mexico and Brazil**

| Countries | Scenarios[1] | U.S.A. | Canada | Mexico | Brazil |
|---|---|---|---|---|---|
| | | ----------1,000 metric tons ---------- | | | |
| Baseline, 2002 | 1 | 12,202 | 994 | 2,416 | 5,746 |
| Mexico 4%, Brazil 50% | 2 | 12,080 | 994 | 2,415 | 5,904 |
| Mexico 15%, Brazil 70% | 3 | 12,074 | 994 | 2,421 | 5,898 |
| Mexico and Brazil 100% | 4 | 12,042 | 993 | 2,450 | 5,888 |

[1]The "Baseline" scenario represents current conditions under which Mexico and Brazil cannot ship
fresh, chilled, or frozen poultry to the United States and Canada.
The percent scenarios are that portion of Mexican and Brazilian production occurring in relatively low-risk of END transmission states.

**Table 5—Sensitivity analysis: Predicted wholesale chicken prices with expansion of low-risk of-END areas in Brazil and Mexico**

| Scenarios[1] | USA | Canada | Mexico | Brazil |
|---|---|---|---|---|
| | ----------Dollars per kg ---------- | | | |
| | Whole chickens | | | |
| Baseline, 2002 | 1.38 | 1.51 | 1.38 | 1.29 |
| Mexico 4%, Brazil 50% | 1.36 | 1.49 | 1.38 | 1.30 |
| Mexico 15%, Brazil 70% | 1.36 | 1.49 | 1.39 | 1.30 |
| Mexico and Brazil 100% | 1.36 | 1.48 | 1.40 | 1.30 |
| | White meat | | | |
| Baseline, 2002 | 1.88 | 2.03 | 1.76 | 1.71 |
| Mexico 4%, Brazil 50% | 1.85 | 1.97 | 1.77 | 1.79 |
| Mexico 15%, Brazil 70% | 1.85 | 1.97 | 1.78 | 1.79 |
| Mexico and Brazil 100% | 1.84 | 1.95 | 1.86 | 1.79 |
| | Dark meat | | | |
| Baseline, 2002 | 0.49 | 0.64 | 0.59 | 0.59 |
| Mexico 4%, Brazil 50% | 0.50 | 0.66 | 0.60 | 0.56 |
| Mexico 15%, Brazil 70% | 0.50 | 0.66 | 0.60 | 0.56 |
| Mexico and Brazil 100% | 0.50 | 0.67 | 0.59 | 0.56 |
| | Other chicken cuts | | | |
| Baseline, 2002 | 0.26 | 0.31 | 0.30 | 0.30 |
| Mexico 4%, Brazil 50% | 0.27 | 0.30 | 0.28 | 0.28 |
| Mexico 15%, Brazil 70% | 0.27 | 0.30 | 0.27 | 0.28 |
| Mexico and Brazil 100% | 0.27 | 0.30 | 0.23 | 0.28 |
| | Mechanically deboned meat | | | |
| Baseline, 2002 | 0.27 | 0.30 | 0.33 | 0.30 |
| Mexico 4%, Brazil 50% | 0.27 | 0.30 | 0.33 | 0.28 |
| Mexico 15%, Brazil 70% | 0.27 | 0.30 | 0.33 | 0.28 |
| Mexico and Brazil 100% | 0.26 | 0.30 | 0.32 | 0.28 |

[1]The "Baseline" scenario represents current conditions under which Mexico and Brazil cannot ship fresh, chilled, or frozen poultry to the United States and Canada. The percent scenarios are that portion of Mexican and Brazilian production occurring in relatively low-risk of END transmission states.

**Table 6—Sensitivity analysis: Predicted value added wholesale chicken prices with expansion of low-risk of-END areas in Brazil and Mexico**

| Scenarios[1] | USA | Canada | Mexico | Brazil |
|---|---|---|---|---|
| | ----------Dollars per kg ---------- | | | |
| | | Whole chickens | | |
| Baseline, 2002 | 2.01 | 2.17 | 1.54 | 1.45 |
| Mexico 4%, Brazil 50% | 1.91 | 2.08 | 1.54 | 1.47 |
| Mexico 15%, Brazil 70% | 1.90 | 2.07 | 1.55 | 1.46 |
| Mexico and Brazil 100% | 1.88 | 2.04 | 1.58 | 1.46 |
| | | White meat | | |
| Baseline, 2002 | 2.48 | 2.74 | 1.88 | 1.84 |
| Mexico 4%, Brazil 50% | 2.44 | 2.68 | 1.88 | 1.94 |
| Mexico 15%, Brazil 70% | 2.43 | 2.68 | 1.88 | 1.93 |
| Mexico and Brazil 100% | 2.42 | 2.66 | 2.00 | 1.93 |
| | | Dark meat | | |
| Baseline, 2002 | 0.81 | 0.97 | 0.64 | 0.66 |
| Mexico 4%, Brazil 50% | 0.82 | 1.00 | 0.65 | 0.63 |
| Mexico 15%, Brazil 70% | 0.82 | 1.00 | 0.65 | 0.63 |
| Mexico and Brazil 100% | 0.82 | 1.01 | 0.65 | 0.63 |

[1]The "Baseline" scenario represents current conditions under which Mexico and Brazil cannot ship fresh, chilled, or frozen poultry to the United States and Canada. The percent scenarios are that portion of Mexican and Brazilian production occurring in relatively low-risk of END transmission states.

**Table 7—Sensitivity analysis: Predicted World Chicken Trade (Product-Weight Basis) with expansion of low-risk-of-END areas in Mexico and Brazil**

| Exporting country | Importing country | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | USA | | Canada | | Mexico | | Brazil | | ROW | total |
| | ----------1,000 metric tons ---------- | | | | | | | | | |
| | Baseline | | | | | | | | | |
| USA | 0 | (0%)[2] | 72 | (100%) | 243 | (21%) | 0 | (0%) | 1816 | 2131 |
| Canada | 0 | (0%) | 0 | (0%) | 0 | (0%) | 0 | (0%) | 0 | 0 |
| Mexico | 0 | (0%) | 0 | (0%) | 0 | (0%) | 0 | (0%) | 0 | 0 |
| Brazil | 0 | (0%) | 0 | (0%) | 0 | (0%) | 0 | (0%) | 1590 | 1590 |
| | Mexico 4%, Brazil 50% | | | | | | | | | |
| USA | 0 | (0%) | 24 | (100%) | 207 | (25%) | 0 | (0%) | 1723 | 1953 |
| Canada | 0 | (0%) | 0 | (0%) | 0 | (0%) | 0 | (0%) | 0 | 0 |
| Mexico | 37 | (68%) | 0 | (0%) | 0 | (0%) | 0 | (0%) | 0 | 37 |
| Brazil | 270 | (100%) | 48 | (100%) | 0 | (0%) | 0 | (0%) | 1557 | 1875 |
| | Mexico 15%, Brazil 70% | | | | | | | | | |
| USA | 0 | (0%) | 23 | (100%) | 201 | (23%) | 0 | (0%) | 1731 | 1955 |
| Canada | 0 | (0%) | 0 | (0%) | 0 | (0%) | 0 | (0%) | 0 | 0 |
| Mexico | 106 | (100%) | 0 | (0%) | 0 | (0%) | 0 | (0%) | 2 | 108 |
| Brazil | 237 | (100%) | 49 | (100%) | 0 | (0%) | 0 | (0%) | 1563 | 1849 |
| | Mexico and Brazil 100% | | | | | | | | | |
| USA | 0 | (0%) | 0 | (0%) | 151 | (31%) | 0 | (0%) | 1740 | 1891 |
| Canada | 0 | (0%) | 0 | (0%) | 0 | (0%) | 0 | (0%) | 0 | 0 |
| Mexico | 211 | (100%) | 20 | (100%) | 0 | (0%) | 0 | (0%) | 9 | 240 |
| Brazil | 204 | (100%) | 52 | (100%) | 0 | (0%) | 0 | (0%) | 1567 | 1823 |

[1]The "Baseline" scenario represents current conditions under which Mexico and Brazil cannot ship
fresh, chilled, or frozen poultry to the United States and Canada.
The percent scenarios are that portion of Mexican and Brazilian production occurring in relatively low-risk of END transmission states.

[2] Numbers in parentheses show the percentage (in product weight terms) of intra-hemisphere value-added exports.

**Table 8—Sensitivity analysis: Predicted changes in economic welfare with expansion of low-risk-of-END areas in Mexico and Brazil**

| Scenarios[1] | USA | Canada | Mexico | Brazil |
|---|---|---|---|---|
| | ----------Millions of U.S.$/year ---------- | | | |
| | Poultry integrators | | | |
| Mexico 4%, Brazil 50% | -80 | -11 | 10 | 62 |
| Mexico 15%, Brazil 70% | -86 | -10 | 23 | 57 |
| Mexico and Brazil 100% | -107 | -14 | 51 | 52 |
| | Further processors | | | |
| Mexico 4%, Brazil 50% | -49 | -1 | 2 | 29 |
| Mexico 15%, Brazil 70% | -57 | -1 | 9 | 26 |
| Mexico and Brazil 100% | -68 | -2 | 17 | 23 |
| | Consumers of wholesale poultry | | | |
| Mexico 4%, Brazil 50% | 149 | 14 | -10 | -62 |
| Mexico 15%, Brazil 70% | 166 | 14 | -23 | -58 |
| Mexico and Brazil 100% | 201 | 20 | -52 | -54 |
| | Total change in surplus | | | |
| Mexico 4%, Brazil 50% | 20 | 2 | 2 | 30 |
| Mexico 15%, Brazil 70% | 23 | 2 | 9 | 25 |
| Mexico and Brazil 100% | 26 | 4 | 16 | 22 |

[1]The percent scenarios are that portion of Mexican and Brazilian production occurring in relatively low-risk of END transmission states.