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Competitiveness of Broiler Producers in North America Under Alternative Free Trade Scenarios

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Highlights

A static spatial programming model was used to evaluate competition among the United States, Canada, and Mexico in the production and trilateral trade of broiler meat. The model includes tariffs on broiler meat traded among the United States, Canada, and Mexico and Canada's import quota and Mexico's import license on broiler meat imports.

The objective of the model was to minimize broiler production and labor processing costs at producing regions, distribution costs of broiler meat from producing regions to consumption regions, and distribution costs of broiler meat from U.S. producing regions to U.S. ports for export abroad. The objective function was optimized subject to the following constraints: 1) lower and upper limits on broiler production, 2) equilibrium transfer conditions for each country, 3) demand for broiler meat in each consuming region, 4) import demand for U.S. broiler meat at ports for export abroad, and 5) import quota limits for Canada and Mexico.

This study indicates freer trade with Canada and Mexico would increase U.S. exports to both countries. Broiler producers would increase production in the United States while producers in Canada and Mexico would reduce broiler production. Specifically, free trade with Mexico would increase production in Texas and free trade with Canada would increase production in the midwestern and southeastern United States.

A 10 percent reduction in production costs in Canada and Mexico would reduce the amount of broiler meat both countries import from the United States. A 20 percent reduction would allow Canada and Mexico to be net exporters to the United States.

Shadow prices indicated Fargo, Portland, Little Rock, Jackson and Charlotte in that order, are the most competitive producing regions in the United States. These regions all increased competitiveness under free trade with Canada and Mexico. Producing regions in Canada and Mexico could only be competitive under free trade by lowering production costs 10 to 20 percent.

The study also indicates Fargo could support a processing facility with an annual capacity of 400 million pounds based on bilateral trade policies between the United States and Canada. The North American Free Trade Agreement (NAFTA) would make the Fargo facility more competitive in the North American broiler market.

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Introduction

Canada and Mexico both have small broiler industries compared to the United States. Canada protects its domestic industry from U.S. competition with an import quota and tariff. Mexico protects its domestic industry with an import license and tariff. The United States places tariffs on both Canadian and Mexican broiler meat.

The U.S.-Canadian Free Trade Agreement (FTA), which took effect in 1989, includes provisions that eliminate bilateral tariffs on broiler meat over a 10-year period. The Canadian tariff is 8.75 percent while the U.S. tariff rate is 4.1 percent. Canada also increased its import quota from 6.3 percent to 7.5 percent of the previous year's production.

A North American Free Trade Agreement (NAFTA) could change the trade relationship in broiler meat between the United States and Mexico. Mexico places a 10 percent tariff on U.S. broiler meat and protects its domestic producers through import licensing while the United States imposes a tariff of 5.9 percent on Mexican broiler meat.

The Mexican government and broiler producers have a preliminary agreement that after signing a Free Trade Agreement, import licenses would continue for five years. A gradual reduction of tariffs would occur over 10 years after import licenses were eliminated. Mexican producers claim tariffs and import licenses offset U.S. producers' "indirect subsidies" in the form of abundant feed supplies and price supports for feed grains and oilseeds.

The majority of both Canadian and Mexican broiler imports come from the United States and have increased since 1986 (Table 1). The United States has supplied 90 to 100 percent of Mexican broiler imports since 1986, and 78 percent of Canadian broiler imports came from the United States in 1990. Before the FTA, Canadian broiler imports from the United States as a percentage of total broiler imports were substantially less.

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TABLE 1. CANADIAN AND MEXICAN BROILER IMPORTS FROM THE UNITED STATES, 1986-1990

	Canada			Mexico		
Year	Imports from U.S.	Total Imports	Percent from U.S.	Imports from U.S.	Total Imports	Percent from U.S.
	---MT---	---MT---	---%---	---MT---	---MT---	---%---
1990	35.1	45.0	78	38.0	38.0	100
1989	30.0	39.0	77	40.5	45.0	90
1988	24.2	41.0	59	44.5	50.0	89
1987	20.9	36.0	58	12.6	14.0	90
1986	14.4	30.0	48	13.3	14.0	95

SOURCE: USDA, FAS, April 1991. "Dairy, Livestock, and Poultry: World Poultry Situation."

The objectives of this study pertain to the competition among the United States, Canada, and Mexico in the production and trade of broiler meat under free trade scenarios. Specific objectives are:

1. To evaluate the U.S.-Canadian FTA effects on broiler production and bilateral trade between the United States and Canada.

2. To evaluate the potential impacts of a North American Free Trade Agreement (NAFTA) on broiler production in the United States, Canada, and Mexico, and trade in broiler meat among the countries.

3. To evaluate the potential impacts of production technology transfer from the United States to Mexico and Canada on production and trade among the countries.

4. To determine whether broiler production would be viable for North Dakota under free trade scenarios.

The Broiler Industry in the United States

The United States is the largest broiler producer in the world, accounting for 35 percent of global output in 1991 (Table 2). Since the 1930s, the U.S. broiler industry has changed gradually from many small, independent farm flocks and small processors to a vertically integrated, efficient industry concentrated in a few production areas. An integrated broiler-producing complex consists of a hatchery, feed mill, processing plant, and field service and management staff. Broiler

TABLE 2. MAJOR PRODUCERS OF BROILER MEAT IN THE WORLD, 1991

Country	Production	Percent of World
	--1,000 MT--	
United States	8,948	35.5
Brazil	2,580	10.2
USSR	1,940	7.7
Japan	1,330	5.3
France	930	3.7

SOURCE: USDA, FAS, April 1991. "Dairy, Livestock, and Poultry: World Poultry Situation."

processors contract with between 150 and 300 growers, depending on the capacity of the processing facility. The industry has been characterized by acquisitions and mergers, which have allowed firms to reach economies of scale. The 20 largest broiler firms accounted for 80 percent of the total broiler slaughter in 1989 (Golz, et al. 1990).

Arkansas, Georgia, Alabama, North Carolina, and Mississippi, in that order, accounted for 61 percent of U.S. broiler production in 1990 (Table 3). Texas, Delaware, Maryland, California, and Virginia are other major producers. The expansion of broiler production in the South is attributed to slow economic development and demise of the cotton industry, which forced farmers to look for alternative agricultural pursuits. Slow economic development in the South has allowed wages and construction costs to remain below the national average (Easterling et al. 1986).

Broiler consumption in the United States is at a historical high, having increased from 36.5 pounds per capita in 1975 to 70 pounds per capita in 1990, surpassing beef as the most consumed meat in the United States. The industry's ability to improve product quality, develop new products, and meet consumers' changing tastes and preferences, plus favorable retail prices and higher disposable incomes, has increased the popularity of broiler meat. The industry has responded to the desire for convenient, time-saving foods. Furthermore, health-conscious consumers perceive that chicken has less fat and may be better for them than other meat products.

TABLE 3. BROILER PRODUCTION FOR THE TOP TEN PRODUCING STATES IN THE UNITED STATES, 1990

State	Production	Percent of U.S.	Cum. Percent
	-billion lbs.-		
Arkansas	2.90	15.5	---
Georgia	2.75	14.7	30.2
Alabama	2.66	14.2	44.4
North Carolina	1.89	10.1	54.5
Mississippi	1.24	6.6	61.1
Texas	1.06	5.7	66.8
Delaware	0.85	4.5	71.3
Maryland	0.83	4.4	75.7
California	0.81	4.3	80.0
Virginia	0.64	3.4	83.4

SOURCE: USDA, ERS, 1991, "Poultry Production, Disposition, and Income."

The United States accounted for 28 percent of world broiler exports in 1990 or 5 percent of its broiler production, with the majority going to the USSR, Japan, and Hong Kong (Table 4). Mexico and Canada were also major importers of U.S. broiler meat.

TABLE 4. TOP FIVE IMPORTERS OF U.S. BROILER MEAT, 1989 AND 1990

Importer	1990	1989
	------1,000 pounds MT------	
USSR	136.75	11.73
Japan	93.76	101.72
Hong Kong	73.48	80.81
Mexico	38.00	40.50
Canada	35.10	30.00

SOURCE: USDA, ERS, "Livestock and Poultry Situation and Outlook," Selected Issues.

The Broiler Industry in Canada

The Canadian broiler industry, while not large compared to the United States, is important in the world broiler market because of its proximity to the United States and because of its complex market intervention. The Canadian Chicken Marketing Agency (CCMA) was formed in 1978 and operates under a federal-provincial agreement to develop and maintain a viable chicken industry in the interest of both producers and consumers. Each year the CCMA establishes a national production quota based on projected consumption, at a price that covers estimated costs of production. The eastern provinces of Quebec and Ontario account for 65 percent of Canadian broiler production (Table 5).

TABLE 5. CANADIAN BROILER PRODUCTION BY PROVINCE, 1990

Province	Production	Percent of Canada	Cum. Percent
	-million lbs.-		
Ontario	430.00	35.10	---
Quebec	370.00	30.20	65.30
British Columbia	155.00	12.65	77.95
Alberta	100.00	8.16	86.11
Atlantic[a]	95.00	7.76	93.87
Manitoba	45.00	3.67	97.54
Saskatchewan	30.00	2.46	100.00

[a]Includes New Brunswick, Newfoundland, Nova Scotia, and Prince Edward Island.

SOURCE: CCMA, "Data Handbook," 1991.

The producer price for broilers in Canada is slightly higher than in the United States; however, the prices Canadian consumers pay are nearly 45 percent above those U.S. consumers pay. The CCMA passes the cost of supporting producers to consumers in the form of higher prices rather than as higher taxes.

Broiler consumption has increased from 29 pounds per capita in 1975 to 49 pounds per capita in 1990. Higher consumer prices may be part of the reason broiler consumption has not grown as much in Canada as in the United States. Canadians in 1990

consumed more beef and pork per capita at 82 and 64 pounds, respectively. Consumer prices for broilers were five percent higher than those for beef and eight percent higher than consumer prices of pork (CCMA, Data Handbook 1991).

Canada exports virtually no broiler meat but imports about seven percent of its broiler meat consumption, primarily from the United States. The U.S.-Canadian Free Trade Agreement (FTA) does not restrict the operation of the CCMA.

The Broiler Industry in Mexico

The Mexican broiler industry is concentrated into a few large vertically integrated firms (Table 6). Under Mexico's anti-inflationary program the government, producers, and distributors agree on ceiling prices. Several small- and medium-sized egg producers shifted to more profitable broiler production due to high ceiling prices. The result was a flood of broiler meat that has lowered prices below the ceiling price, indicating market forces are establishing the price level.

TABLE 6. STRUCTURE OF MEXICO'S BROILER INDUSTRY, 1989

Broiler Houses	Capacity	Percent of Total Production
---number---	--number of head--	
932	less than 60,000	14.0
85	60,000 - 120,000	18.0
29	120,000 - 240,000	12.0
11	more than 241,000	56.0

SOURCE: Agricultural Affairs Office, Mexico City, 1991. "Gedes Voluntary Report."

The main broiler producing states in 1990 were Jalisco, Mexico, Veracruz, Guanajuato, and Nuevo Leon (Table 7). The National Association of Poultry Producers indicates utilization of broiler production facilities is at 75 percent in Mexico.

TABLE 7. FIVE MAJOR PRODUCING STATES OF BROILER MEAT IN MEXICO, 1990

State	Production	Percent of Mexico	Cum. Percent
	-million lbs.-		
Jalisco	178.60	12.30	---
State of Mexico	165.53	11.40	23.70
Veracruz	129.23	8.90	32.60
Guanajuato	124.87	8.60	41.20
Nuevo Leon	107.45	7.40	48.60

SOURCE: Agricultural Affairs Office, Mexico City, 1991. "Gedes Voluntary Report."

Broiler meat consumption has risen slower in Mexico than in the United States and Canada. Broiler consumption has increased from 13 pounds per capita in 1980 to 17.4 pounds per capita in 1990. Mexico City consumes over 50 percent of Mexican broiler meat production. The public market presentation, which is a whole bird, including the offals, head and feet, accounts for 80 percent of total sales in Mexico. Consumers in Mexico do not prefer breast meat over other parts as do U.S. consumers. Except for border areas, broiler producers in Mexico have been able to satisfy domestic consumption.

The United States supplies Mexico with most of its broiler imports, primarily hind quarters (legs) that can be sold in Mexico for 80 to 90 percent more than in the United States. This is a result of the comparative advantage of the U.S. broiler industry and Mexico's consumption patterns.

Model Development

The model used for this study is a static spatial programming model based on a mathematical programming algorithm. The objective of the model is to minimize production costs of broilers at producing regions, labor costs for processing broilers, and distribution costs of broiler meat from producing regions to consuming regions and from producing regions to ports. Other processing costs of broiler meat are not included in this study and are assumed to be equal for all producing regions.

Transportation costs of live broilers from producing regions to processing plants is not included in the study since processing plants are located near broiler producers to avoid injury and/or death loss in transit. The objective function is subject to a set of linear constraints representing broiler production capacity, demand for broiler meat, and import quotas in Canada and Mexico. Demand for broiler meat in the model is assumed to be perfectly inelastic.

The United States is divided into 11 producing regions (Figure 1) and 24 consuming regions (Figure 2). Canada is divided into seven producing and consuming regions while Mexico has three producing regions and four consuming regions (Figures 1 and 2). The mode of transporting broiler meat from producing regions to consuming regions was refrigerated truck. The objective function of the model is written as follows:

$$1.\quad \text{Min } C = \sum_{i=1}^{I} PC_i Q_i + \sum_{m=1}^{M} PC_m Q_m + \sum_{c=1}^{C} PC_c Q_c +$$

$$\sum_{i=1}^{I}\sum_{j=1}^{J} TM_{ij} Q_{ij} + \sum_{m=1}^{M}\sum_{h=1}^{H} TM_{mh} Q_{mh} +$$

$$\sum_{c=1}^{C}\sum_{k=1}^{K} TM_{ck} Q_{ck} + \sum_{i=1}^{I}\sum_{h=1}^{H} TM_{ih} Q_{ih} +$$

$$\sum_{i=1}^{I}\sum_{k=1}^{K} TM_{ik} Q_{ik} + \sum_{m=1}^{M}\sum_{j=1}^{J} TM_{mj} Q_{mj} +$$

$$\sum_{c=1}^{C}\sum_{j=1}^{J} TM_{cj} Q_{cj} + \sum_{i=1}^{I}\sum_{p=1}^{P} TM_{ip} Q_{ip}$$

where

i = index for U.S. producing regions
m = index for Mexican producing regions
c = index for Canadian producing regions
j = index for U.S. consuming regions
h = index for Mexican consuming regions
k = index for Canadian consuming regions
p = index for U.S. ports
PC = Production cost for producing regions
Q = Quantity of broiler meat
TM = Transportation costs from producing regions to consuming regions and ports

Figure 1. Broiler Production Regions for the United States, Canada, and Mexico

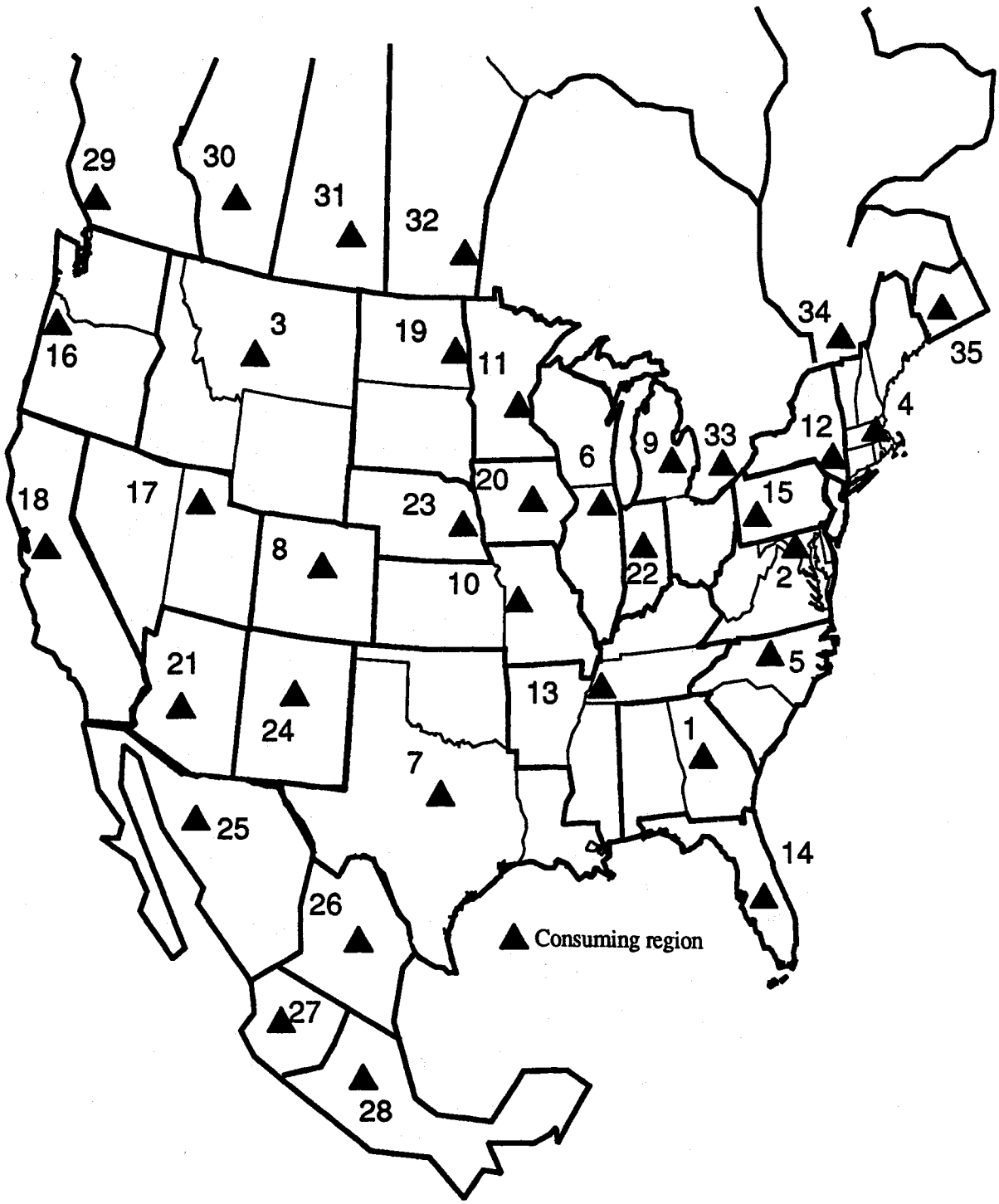

Figure 2. Broiler Consumption Regions for the United States, Canada, and Mexico

The objective function in equation 1 is the summation of 11 separate activities. The first three summations represent total production cost in producing broilers for the United States, Mexico, and Canada. The eight remaining summations associated with shipments of broiler meat are (1) shipments from U.S. producing regions to U.S. consuming regions, (2) shipments from Mexican producing regions to Mexican consuming regions, (3) shipments from Canadian producing regions to Canadian consuming regions, (4) shipments from U.S. producing regions to Mexican consuming regions, (5) shipments from U.S. producing regions to Canadian consuming regions, (6) shipments from Mexican producing regions to U.S. consuming regions, (7) shipments from Canadian producing regions to U.S. consuming regions, and (8) shipments from U.S. producing regions to U.S. ports. All costs of these activities are measured in dollars per 1,000 lbs. RTC.

Twelve linear constraints are placed on the objective function as follows:

2. $UL_i \geq Q_i \geq LL_i$

3. $UL_m \geq Q_m \geq LL_m$

4. $UL_c \geq Q_c \geq LL_c$

5. $$\sum_{i=1}^{I} Q_{ij} + \sum_{m=1}^{M} Q_{mj} + \sum_{c=1}^{C} Q_{cj} \geq D_j$$

6. $$\sum_{m=1}^{M} Q_{mh} + \sum_{i=1}^{I} Q_{ih} \geq D_h$$

7. $$\sum_{c=1}^{C} Q_{ck} + \sum_{i=1}^{I} Q_{ik} \geq D_k$$

8. $$\sum_{i=1}^{I} Q_{ip} \geq D_p$$

9. $$\sum_{i=1}^{I} \sum_{k=1}^{K} Q_{ik} \leq 97,350$$

$$10. \quad \sum_{i=1}^{I} \sum_{h=1}^{H} Q_{ih} \leq 90,988$$

$$11. \quad \sum_{j=1}^{J} Q_{ij} + \sum_{h=1}^{H} Q_{ih} + \sum_{k=1}^{K} Q_{ik} = Q_i$$

$$12. \quad \sum_{h=1}^{H} Q_{mh} + \sum_{j=1}^{J} Q_{mj} = Q_m$$

$$13. \quad \sum_{k=1}^{K} Q_{ck} + \sum_{j=1}^{J} Q_{cj} = Q_c$$

where

UL_i (LL_i) = maximum (minimum) amount of broiler production in U.S. producing regions

UL_m (LL_m) = maximum (minimum) amount of broiler production in Mexican producing regions

UL_c (LL_c) = maximum (minimum) amount of broiler production in Canadian producing regions

D_j = U.S. domestic consumption of broiler meat in consuming region j

D_h = Mexican domestic consumption of broiler meat in consuming region h

D_k = Canadian domestic consumption of broiler meat in consuming region k

D_p = Foreign import demand at U.S. ports for broiler meat.

Equations 2 through 4 represent broiler production constraints for broiler production in the United States, Mexico, and Canada. The total broiler production should be less than or equal to the upper limit and more than or equal to the lower limit.

Equations 5, 6, and 7 represent demand for broiler meat in each consuming region within the United States, Mexico, and Canada, respectively. The total amount of broiler meat shipped from producing regions to a consuming region should be equal to or greater than the quantity demanded in the consuming region. Equation 8 represents foreign import demand for broiler meat at each U.S. port. Interpretation of equation 8 is similar to equations 5, 6, and 7.

Equations 9 and 10 represent the import quota limits for Canada and Mexico. The total amount of broiler meat exported from U.S. producing regions to Canadian and Mexican consuming regions should be equal to or less than the import quota for each country.

Equations 11, 12, and 13 represent equilibrium transfer conditions for each country. The total amount produced in each country should be equal to the amount used for domestic consumption plus exports.

Data

The model requires costs associated with production activities (production costs), transportation activities (truck rates), and right-hand side values associated with constraints (production capacity, domestic demand in each country, and import quotas).

Production Costs and Capacities

Production costs for broilers in the United States, Canada, and Mexico include the following costs: energy, building, grower payment, and feed costs. These costs account for 80 percent of production costs. Production costs were calculated on an eviscerated or ready-to-cook basis (Table 8).

Production cost data for the United States were taken from an agricultural economics report entitled "Preliminary Economic Feasibility of Broiler Production in North Dakota" (Golz et al. 1990). Feed costs were updated for this report to reflect the lower feed prices relative to 1990.

Production costs for Canadian broiler production were based on the monthly "Cost of Production Update" from the CCMA (June 1991). Although this update includes a detailed breakdown of Canadian broiler production costs, only costs for feed, energy, grower payment, and depreciation were used to be consistent with U.S. production costs (Table 8).

TABLE 8. PRODUCTION AND PRODUCTION COST BY PRODUCING REGIONS FOR THE UNITED STATES, MEXICO, AND CANADA, 1990

Distribution Center	Production	Production Cost	Labor Cost[a]	Total Cost
	-million lbs. RTC-	----------$/1,000 lbs. RTC----------		
United States				
1. Birmingham	2,600	249.99	68.48	318.47
2. Atlanta	3,600	252.81	81.52	334.33
3. Jackson	1,200	241.85	68.48	310.33
4. Charlotte	1,900	251.72	74.76	326.48
5. Little Rock	3,200	240.66	66.57	307.23
6. Dallas	1,400	253.55	81.43	334.98
7. San Francisco	800	293.74	106.76	400.50
8. Portland	190	292.95	86.67	379.62
9. Baltimore	2,700	254.80	97.52	352.32
10. Minneapolis	190	250.00	92.48	342.48
11. Fargo	156[b]	250.00	79.33	329.33
Mexico				
12. Monterrey	190	377.27	13.43	390.70
13. Mexico City	1,100	377.27	13.43	390.70
14. Hermosillo	160	377.27	13.43	390.70
Canada				
15. Vancouver	155	308.74	110.76	419.50
16. Calgary	100	296.23	97.43	393.66
17. Regina	30	283.72	120.57	404.29
18. Winnipeg	45	291.58	102.95	394.53
19. Toronto	430	272.49	111.52	384.01
20. Montreal	370	304.74	103.05	407.79
21. Fredericton	95	334.11	89.91	424.02

[a]Labor costs for processing.
[b]Amount to support one standard-sized processing facility.

Mexico's National Association of Poultry Producers report that broiler production costs are 28 percent higher than U.S. production costs (USDA, FAS 1991). Mexico's production costs were based on data from the Office of the Agricultural Counselor (Embassy of Mexico 1991).

Actual broiler production for 1990 in the United States, Canada, and Mexico was used for this study (Table 8). Production by region for the United States was adapted from "Poultry Production, Disposition, and Income" (USDA, ERS 1991). Production for Canada by province was from "Data Handbook" (CCMA 1991). Broiler production in Mexico was from the Office of the Agricultural Counselor (Embassy of Mexico 1991).

Labor processing costs were also included for the three countries. Labor costs for the United States were adapted from hourly wages for food and kindred products processing by producing region (U.S. Department of Labor 1991). Labor costs for broiler processing in Canada were adapted from hourly wages for food processing in Canada by province (Statistics Canada 1991). Labor costs for broiler processing in Mexico were adapted from hourly wages for maquiladoras, which are foreign-owned plants that produce (broiler meat in this case) for export to the United States (Embassy of Mexico 1991).

Marketing Costs

Transportation costs among the three countries are divided into two parts: domestic transportation costs between producing regions and consumption centers and transportation costs for export between producing regions and consumption centers. The domestic transportation costs for the United States were calculated as $1.25 per mile for a refrigerated truck (USDA, Agricultural Marketing Service, Transportation and Marketing Division 1991). Domestic transportation costs for Canada were from the CCMA (1991) and were based on a 1988 survey. Transportation costs for Mexico could not be obtained; therefore, the U.S. rate was used for domestic transportation in Mexico. Transportation costs for exports among the three countries were calculated using the U.S. rate, since Canadian producing and consuming centers are near the U.S. border and transportation rates for Mexico were not available.

Tariffs

The United States, Canada, and Mexico all have tariffs on broiler imports. Mexico's tariff on U.S. broiler meat is the highest at 10 percent (Table 9). Canadian tariffs on U.S. broiler meat declined from 12.5 percent in 1988 to 8.75 percent in 1991, while U.S. tariffs on Canadian broiler meat declined from 5.9 percent in 1988 to 4.1 percent in 1991. Tariffs declined in both countries due to the U.S.-Canadian FTA and are scheduled to be eliminated by 1998. U.S. tariffs on Mexican broiler meat are 5.9 percent (Table 9).

TABLE 9. TARIFF RATES FOR BROILER MEAT AMONG THE UNITED STATES, CANADA, AND MEXICO, 1990

Importing Country	Exporting Countries		
	United States	Canada	Mexico
	percent		
United States	----	4.10	5.90
Canada	8.75	----	----
Mexico	10.00	----	----

SOURCE: Embassy of Mexico, Canadian Chicken Marketing Agency, and the U.S. International Trade Commission, all 1991.

Constraints

The upper limit of production capacity within each producing region was defined as 40 percent more than actual production in 1990. The lower limit of production is 40 percent of actual production in 1990.

Canada and Mexico use trade policies to protect their domestic broiler producers from direct competition with producers in the United States. Canada uses an import quota equal to 7.5 percent of the previous year's broiler production in Canada. This study uses 7.5 percent of forecasted broiler production for 1991 as Canada's quota (Table 10). Mexico uses an import licensing policy to protect its domestic producers, which cannot be measured quantitatively. This study uses a three-year average, 1988-1990, of U.S. exports to Mexico taken from "Livestock and Poultry Situation and Outlook" (USDA 1991) as a proxy for Mexico's import license (Table 10).

TABLE 10. MAGNITUDE OF THE IMPORT QUOTA FOR CANADA AND MEXICO, 1990

Country	Import Quota
	-million lbs.-
Canada	97.35
Mexico	90.99

SOURCE: USDA, Livestock and Poultry Situation and Outlook, USDA, 1991.

Demand for broiler meat in each consuming region in the United States, Canada, and Mexico was calculated by multiplying per capita consumption for 1990 in each country by the region's population (Table 11). Per capita consumption for each country was from "Dairy, Livestock, and Poultry: World Poultry Situation" (USDA, FAS 1991). Population for the United States was taken from "Statistical Abstract of the United States" (U.S. Department of Commerce 1991), Canadian population was from Statistics Canada (1991) and Mexico's population was from the Embassy of Mexico (1991).

TABLE 11. CONSUMPTION BY CONSUMING REGION FOR THE UNITED STATES, MEXICO, AND CANADA, 1990

Consumption Center	Consumption
	---million lbs.---
United States	
1. Atlanta	736.32
2. Baltimore	939.99
3. Billings	158.13
4. Boston	915.46
5. Charlotte	708.05
6. Chicago	1,142.54
7. Dallas	1,704.64
8. Denver	230.58
9. Detroit	1,409.94
10. Kansas City	531.65
11. Minneapolis	306.25
12. New York	1,800.47
13. Memphis	944.02
14. Orlando	905.66
15. Pittsburgh	831.74
16. Portland	539.63
17. Salt Lake	204.75
18. San Francisco	2,083.20
19. Fargo	93.45
20. Des Moines	194.39
21. Phoenix	256.55
22. Indianapolis	388.08
23. Omaha	110.46
24. Albuquerque	106.05
Mexico	
25. Chihuahua	170.33
26. Monterrey	196.43
27. Guadalajara	262.06
28. Mexico City	781.41
Canada	
29. Vancouver	161.24
30. Calgary	126.61
31. Regina	50.19
32. Winnipeg	55.14
33. Toronto	497.62
34. Montreal	344.07
35. Fredericton	117.28

Import demand for U.S. broiler meat by the USSR, Japan, and Hong Kong was calculated by customs district (Table 12). This information was acquired from a CD-ROM disk "U.S. Exports of Merchandise" (U.S. Department of Commerce, Bureau of the Census 1991). Transportation costs were calculated from producing regions to each customs district; however, ocean freight costs to ports in each of the importing countries were not included due to data constraints.

TABLE 12. IMPORT DEMAND BY CUSTOMS DISTRICT AND MAJOR IMPORTING COUNTRIES, AND TOTAL IMPORT DEMAND BY CUSTOMS DISTRICT FOR U.S. BROILER MEAT, 1991

Customs District	Importing Country			Total
	USSR	Hong Kong	Japan	
	1,000 MT			
Mobile, AB	114.35	--	--	114.35
Tampa Bay, FL	22.11	--	--	22.11
Seattle, WA	--	10.86	10.71	21.57
San Francisco, CA	--	24.08	64.42	88.50
Norfolk, VA	--	26.66	5.19	31.85
Charleston, SC	--	8.41	1.85	10.26
Savannah, GA	--	9.31	10.71	20.02

SOURCE: U.S. Department of Commerce, Bureau of the Census, "U.S. Exports of Merchandise," 1991.

Results

Results of this study are presented in four sections. First, a discussion of broiler production by region is presented and analyzed for Model 1 (base model) and alternative models. Second, broiler trade among the three nations is discussed for Model 1 and alternative models. Third, broiler shipments from U.S. producing regions to U.S. ports for export abroad are discussed. Fourth, broiler production competitiveness is discussed for Model 1 and alternative models.

Model 1 is the base model with existing trade policies among the United States, Canada, and Mexico. Model 2 eliminates tariffs between the United States and Canada. Model 3 additionally eliminates the Canadian import quota on broiler meat. Model 4 eliminates the Mexican import license (quota), and Model 5 additionally eliminates tariffs between the United States and Mexico. Model 6 simulates complete free trade among the United States, Canada, and Mexico; Models 7 and 8 simulate the impact of Canada and Mexico reducing production costs under free

trade by 10 and 20 percent. Model 9 doubles the processing capacity at Fargo.

Optimal Broiler Production

Model 1 simulates competition among the United States, Canada, and Mexico based on production costs, labor wages for processing, and transportation costs. Also included are tariffs among the three countries, Canada's import quota and Mexico's import license. The actual and optimal levels of broiler production by region for the United States, Canada, and Mexico are listed in Table 13.

Comparing 1990 actual broiler production by region in each country with optimal production levels obtained from Model 1 indicates Atlanta, Dallas, San Francisco, and Baltimore produce less than actual production. The other producing regions in the United States produce more than actual production in 1990. Mexico City and Hermosillo produce about the same as actual production in 1990, while less than actual is produced in Monterrey. All the producing regions in Canada, except for those located at Montreal and Fredericton, produce more than actual production in 1990. Both Montreal and Fredericton produce less than actual 1990 production.

The impact of the U.S.-Canadian FTA on broiler production is simulated in Model 2. The removal of tariffs under the FTA does not change production levels for the United States or Canada (Table 13). Thus, Model 2 is not presented in Table 13 because production levels did not change.

Model 3 simulates the impact of removing Canada's import quota in addition to tariff removal between the two countries in Model 2. Birmingham, Dallas, and Minneapolis all increase production. All the producing regions in Canada produce less except for Fredericton which produces its lower limit in Model 1 (Table 13).

The impact of eliminating Mexico's import license (quota) is simulated in Model 4. The only changes in U.S. production from Model 1 are at Birmingham, Dallas, and Minneapolis, which all increase production. All three producing regions in Mexico have a large decrease in production relative to Model 1. Both Mexico City and Hermosillo produce less than half of that produced in Model 1.

Model 5 additionally eliminates U.S.-Mexican tariffs on broiler meat; production levels did not change in either the United States or Mexico relative to Model 4.

TABLE 13. OPTIMAL BROILER PRODUCTION BY PRODUCING REGION FOR ALTERNATIVE MODELS

Region	1990 Actual	Model No. 1	3	4	5	6	7	8	9
	million lbs								
United States									
1. Birmingham	2,600.00	3,912.30	4,160.00	4,160.00	4,160.00	4,160.00	4,160.00	2,858.10	3,712.60
2. Atlanta	3,600.00	1,440.00	1,440.00	1,440.00	1,440.00	1,440.00	1,440.00	1,440.00	1,440.00
3. Jackson	1,200.00	1,920.00	1,920.00	1,920.00	1,920.00	1,920.00	1,920.00	1,920.00	1,920.00
4. Charlotte	1,900.00	3,072.00	3,072.00	3,072.00	3,072.00	3,072.00	3,072.00	3,072.00	3,072.00
5. Little Rock	3,200.00	4,992.00	4,992.00	4,992.00	4,992.00	4,992.00	4,992.00	4,992.00	4,992.00
6. Dallas	1,400.00	560.00	1,076.10	1,050.60	1,050.60	1,815.30	560.00	560.00	560.00
7. San Francisco	800.00	320.00	320.00	320.00	320.00	320.00	320.00	320.00	320.00
8. Portland	190.00	307.20	307.20	307.20	307.20	307.20	307.20	307.20	307.20
9. Baltimore	2,700.00	1,080.00	1,080.00	1,080.00	1,080.00	1,080.00	1,080.00	1,080.00	1,080.00
10. Minneapolis	190.00	306.25	307.20	307.20	307.20	307.20	306.25	306.25	306.25
11. Fargo	--[a]	199.68	199.68	199.68	199.68	199.68	199.68	199.68	399.36
Mexico									
12. Monterrey	190.00	105.44	105.44	76.00	76.00	76.00	76.00	307.20	105.44
13. Mexico City	1,100.00	1,043.50	1,043.50	440.00	440.00	440.00	967.470	1,103.00	1,043.50
14. Hermosillo	160.00	170.33	170.33	64.00	64.00	64.00	124.88	256.00	170.33
Canada									
15. Vancouver	155.00	161.24	62.00	161.24	161.24	62.00	248.32	248.32	161.24
16. Calgary	100.00	126.61	40.00	126.61	126.61	40.00	160.00	160.00	126.61
17. Regina	30.00	48.00	12.00	48.00	48.00	12.00	48.00	48.00	48.00
18. Winnipeg	45.00	55.14	18.00	55.14	55.14	18.00	18.00	72.00	39.25
19. Toronto	430.00	497.62	172.00	497.62	497.62	172.00	497.62	688.64	497.62
20. Montreal	370.00	328.18	148.00	328.18	328.18	148.00	148.00	592.64	344.07
21. Fredericton	95.00	38.00	38.00	38.00	38.00	38.00	38.00	152.32	38.00

[a]Not reported to avoid disclosing individual operations.

Model 6 eliminates all trade restrictions simultaneously among the three countries. Birmingham, Dallas, and Minneapolis all increase production in the United States. Atlanta is the only producing region in the United States that does not produce more than its lower limit under free trade. Production levels for Mexico decrease in all three producing regions relative to Model 1 and are the same as those in Models 4 and 5. Production in all Canadian producing regions decrease to levels in Model 3, except in Fredericton.

Model 7 determines the impacts on Model 6 (complete free trade) when production costs in Canada and Mexico decrease by 10 percent. Dallas and Minneapolis decrease production in the United States. All producing regions in Canada except Winnipeg, Montreal, and Fredricton increase production while Hermosillo and Mexico City increase production in Mexico.

Model 8 simulates the impacts of reducing production costs in Canada and Mexico by 20 percent. The result is a decline in production at Birmingham. In Mexico all producing regions increase production further while in Canada Toronto, Montreal, and Fredericton increase production. Model 8 is the only model in which Fredericton produces more than the lower limit (Table 13).

Model 9 is the base model with double the production capacity at Fargo. Fargo uses the additional production capacity while production at Birmingham and Winnipeg decreases and production at Montreal increases.

Bilateral Trade

The movement of broiler meat from the United States to Canada and Mexico in Model 1 is limited by Canada's import quota and Mexico's import license (quota). These quotas are fulfilled in both countries, resulting in the United States' exporting 90.99 million pounds (mpd) to Mexico (all from Dallas to Monterrey), and 97.35 mpd to Canada (Baltimore to Montreal and Fredericton, and Fargo to Regina). The United States does not import any broiler meat from Mexico and Canada (Table 14).

TABLE 14. TRILATERAL TRADE IN BROILER MEAT AMONG THE UNITED STATES, MEXICO, AND CANADA FOR ALTERNATIVE MODELS

	U.S. to:		Mexico to:	Canada to:
	Mexico	Canada	U.S.	U.S.
	million lbs.			
Model 1	90.99	97.35	0.00	0.00
Model 2	90.99	97.35	0.00	0.00
Model 3	90.99	862.14	0.00	0.00
Model 4	830.23	97.35	0.00	0.00
Model 5	894.23	97.35	64.00	0.00
Model 6	894.23	862.14	64.00	0.00
Model 7	366.76	314.67	124.88	120.47
Model 8	0.00	2.19	256.00	611.97
Model 9	90.99	97.35	0.00	0.00

Eliminating tariffs between the United States and Canada in Model 2 does not change trade among the three nations. Model 3 eliminated Canada's import quota, which increases U.S. exports to Canada from 97.35 mpd (Model 1) to 862.14 mpd. Canadian exports to the United States do not change from Model 1 to Model 3. The increase in U.S. exports to Canada is primarily due to an increase in shipments from Baltimore to Montreal (15.89 mpd for Model 1 to 196.07 mpd for Model 3) and new shipments from Birmingham to Toronto (325.62 mpd), Little Rock to Vancouver (99.24 mpd), and Fargo to Calgary, Regina, and Winnipeg (86.61 mpd, 38.19 mpd, and 37.14 mpd).

Model 4 eliminates the Mexican quota from Model 1, increasing U.S. exports to Mexico. Shipments of broiler meat into Mexico from the United States amount to 830.23 mpd, all of which originates from Dallas. All four consuming regions in Mexico import from the United States. The United States does not import any broiler meat from Mexico.

Model 5 eliminates tariffs between the United States and Mexico from Model 4, increasing U.S. exports from 830.23 mpd in Model 4 to 894.23 mpd in Model 5. The majority of exports still originate from Dallas; however, 36.23 mpd originate from Jackson. Mexican exports of 64.00 mpd, originating at Hermosillo, are shipped to Phoenix in the United States.

Model 6 removes all trade restrictions among the three nations, resulting in U.S. exports to Mexico equal to Model 5

(894.23 mpd) and exports to Canada equal to Model 3 (862.14 mpd). U.S. imports from Canada and Mexico are equal to those in Model 5. Comparing Model 6 to Model 1 indicates the United States could greatly increase exports to Canada and Mexico under complete free trade.

Model 7 determines the impacts on Model 6 (complete free trade) when production costs in Canada and Mexico decrease by 10 percent. Canadian imports decrease from 862.14 mpd in Model 6 to 314.67 mpd, and Mexican imports decrease from 894.23 mpd to 366.76 mpd. Mexican exports to the United States increase from 64.0 mpd in Model 6 to 124.88 mpd in Model 7, and Canadian exports to the United States increase from zero in Model 6 to 120.47 mpd in Model 7. The majority is due to shipments from Vancouver to Portland, amounting to 87.08 mpd.

Model 8 reduces production costs by an additional 10 percent in Canada and Mexico. The result is Mexico imports no broiler meat from the United States, and Canada imports 2.19 mpd (Fargo to Regina). The United States, however, imports 256.00 mpd and 611.97 mpd from Mexico and Canada, respectively. Mexico exports 256.00 mpd to Phoenix from Hermosillo. The major imports from Canada include 248.57 mpd (Montreal to Boston) and 191.02 mpd (Toronto to Boston).

Model 9 increases production capacity at Fargo for Model 1. Fargo increases exports to Canada from 2.19 mpd in Model 1 (Fargo to Regina) to 18.08 mpd (Fargo to Regina and Winnipeg).

Optimal Shipments of Broiler Meat to Ports

The movement of broiler meat for Model 1 from producing regions to customs districts for export to the USSR, Hong Kong, and Japan are as follows: Jackson to Mobile and Atlanta to Tampa for export to the USSR, Atlanta to Charleston and Savannah for export to Hong Kong and Japan, Charlotte to Norfolk for export to Hong Kong and Japan, San Francisco to San Francisco for export to Hong Kong and Japan, and Portland to Seattle for export to Hong Kong and Japan (Table 15). None of the shipments for any of the alternative models changed from the base model.

TABLE 15. SHIPMENTS OF BROILER MEAT FROM PRODUCING REGIONS TO CUSTOMS DISTRICTS FOR EXPORT TO THE USSR, HONG KONG, AND JAPAN

Customs Districts	Producing Regions				
	Birmingham	Atlanta	Charlotte	San Francisco	Portland
	million lbs.				
Mobile	251.57	--	--	--	--
Tampa	48.64	--	--	--	--
Seattle	--	--	--	--	47.45
San Francisco	--	--	--	194.70	--
Norfolk	--	--	70.07	--	--
Charleston	--	22.57	--	--	--
Savannah	--	44.04	--	--	--

Production Competitiveness

Competitiveness is measured using shadow prices generated from the upper limit of broiler production in each producing region. The shadow price indicates the amount the objective function will change if an additional 1,000 pounds of broiler meat is produced in that particular region.

Shadow prices indicate Fargo, Portland, Little Rock, Jackson, and Charlotte, in that order, are the most competitive producing regions in the United States for Model 1. Fargo and Portland have a transportation advantage over the South in supplying broiler meat to the Midwest and Pacific Northwest, respectively. These producing regions also have a transportation advantage over the South in supplying broiler meat to Canada. Little Rock and Jackson have the lowest production costs among southern producing regions and are located near major consumption centers.

When investment costs for an integrated broiler facility are considered, the Midwest and Pacific Northwest may not be as competitive. Also, these regions should not be considered as the most optimal locations for broiler expansion in North America, but rather the most optimal relative to existing production. Other states having little or no broiler production could be more optimal sights for broiler expansion.

None of the producing regions in Mexico are competitive in Model 1 due to high production costs and the proximity of Mexico to major broiler producing regions located in the southern United States.

The only producing region in Canada that is competitive is Regina, due to the lack of production in surrounding provinces and states in the United States.

The alternative models have some changes in competitiveness. Shadow prices for Model 2 are not listed in Table 16 because competitiveness did not change. Eliminating the Canadian quota (Model 3) makes Regina less competitive and Birmingham and Minneapolis more competitive. Competitiveness at Fargo, Portland, Little Rock, Jackson and Charlotte increases.

Eliminating the Mexican import license (Model 4) increases the competitive position of Birmingham, Jackson, Charlotte, Little Rock, Portland, Minneapolis, and Fargo due to increased exports of broiler meat to Mexico. Also eliminating Mexican tariffs (Model 5) further increases the competitive position of these producing regions.

Complete free trade (Model 6) increases the competitive position of Birmingham, Jackson, Charlotte, Little Rock, Portland, Minneapolis, and Fargo, while Regina is not competitive under free trade. Reducing production costs (Model 7) by 10 percent in Canada and Mexico resulted in Vancouver, Calgary and Regina being competitive. For Mexico, lower production costs made Hermosillo and Mexico City produce more than the lower limit. Competitiveness decreases for all U.S. producing regions which were competitive in Model 6. Reducing production costs in Canada and Mexico by 20 percent (Model 8) increases competitiveness at all Canadian producing regions and all Mexican producing regions except Mexico City and reduces competitiveness of U.S. producing regions.

When production capacity is doubled at Fargo in Model 9, competitiveness at Fargo, Portland, Little Rock, and Regina declines relative to Model 1, but Fargo still produces broiler meat at its maximum capacity.

TABLE 16. SHADOW PRICES FOR SELECTED MODELS BY PRODUCING REGION

	Model							
Region	1	3	4	5	6	7	8	9
United States								
Birmingham	0.00	(7.02)	(4.89)	(5.26)	(7.02)	(0.48)	0.00	0.00
Atlanta	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jackson	(5.00)	(12.02)	(9.89)	(10.26)	(12.02)	(5.48)	(5.00)	(5.00)
Charlotte	(2.51)	(10.07)	(7.40)	(7.77)	(10.07)	(3.53)	(2.44)	2.51
Little Rock	(11.34)	(18.26)	(16.23)	(16.60)	(18.26)	(11.82)	(11.24)	(11.24)
Dallas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
San Francisco	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Portland	(15.23)	(22.15)	(20.12)	(20.49)	(22.15)	(15.71)	(15.13)	(15.13)
Baltimore	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Minneapolis	0.00	(10.64)	(3.38)	(3.75)	(10.64)	0.00	0.00	0.00
Fargo	(18.38)	(30.53)	(23.27)	(23.64)	(30.53)	(18.86)	(18.28)	(14.14)
Mexico								
Monterrey	0.00	0.00	0.00	0.00	0.00	0.00	(13.83)	0.00
Mexico City	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hermosillo	0.00	0.00	0.00	0.00	0.00	0.00	(38.49)	0.00
Canada								
Vancouver	0.00	0.00	0.00	0.00	0.00	(8.27)	(49.64)	0.00
Calgary	0.00	0.00	0.00	0.00	0.00	(14.14)	(52.92)	0.00
Regina	(5.07)	0.00	(5.07)	(5.07)	0.00	(0.44)	(40.29)	(1.46)
Winnipeg	0.00	0.00	0.00	0.00	0.00	0.00	(26.16)	0.00
Toronto	0.00	0.00	0.00	0.00	0.00	0.00	(30.12)	0.00
Montreal	0.00	0.00	0.00	0.00	0.00	0.00	(21.78)	0.00
Fredericton	0.00	0.00	0.00	0.00	0.00	0.00	(7.11)	0.00

Note: Numbers in parentheses are negative.

Summary and Concluding Remarks

A spatial equilibrium model was developed to evaluate optimal production and trilateral trade of broiler meat among the United States, Canada, and Mexico. The model includes current trade policies and production, labor processing, and marketing costs for broiler meat in each country. The trade policies are tariffs between the United States and Canada, the United States and Mexico, Canada's import quota, and Mexico's import license. Alternative models evaluate the elimination of these trade policies on optimal production and trilateral trade.

The elimination of tariffs between the United States and Canada under the FTA result in no change in production or trade patterns between the two countries. The removal of Canada's import quota (Model 3) increases U.S. production at Birmingham, Dallas and Minneapolis. U.S. exports to Canada increase from 97.35 mpd to 862.14 mpd and originate from Baltimore, Birmingham, Little Rock, and Fargo. Production declines to the lower limit for all producing regions in Canada. There are no Canadian exports to the United States. Eliminating these trade barriers has little impact on competitiveness. This implies broiler producers in Baltimore, Birmingham, Little Rock, and Fargo could benefit from freer trade with Canada.

The elimination of the Mexican import license increases U.S. production at Dallas significantly which is exported to Mexico. U.S. exports increase from 90.99 mpd (Model 1) to 830.23 mpd (Model 4). The further elimination of Mexican import tariffs (Model 5) increases U.S. exports to 894.23 mpd which is offset by Mexican exports of 64.0 mpd from Hermosillo to Phoenix. The producing regions in Mexico produce at their lower limits for Models 4 and 5. Shadow prices indicate broiler production in the United States becomes more competitive through the elimination of Mexican trade barriers. Broiler producers in Texas and surrounding states could benefit greatly from freer trade with Mexico.

Model 6 simultaneously eliminates trade barriers between the United States and Canada and the United States and Mexico. The results in terms of production, trade, and competitiveness are similar to Models 3, 4, and 5.

A North American Free Trade Agreement would benefit the United States through increased exports to Canada and Mexico. Producing regions in the Midwest, South Central, and Southeastern United States would increase production and producing regions in Canada and Mexico would reduce production.

A 10 percent reduction in production costs for both Canada and Mexico (Model 7) under free trade results in decreased production at Dallas and Minneapolis and increased production in

both Canada and Mexico. U.S. exports to Canada and Mexico also decline while both Canada and Mexico increase exports to the United States. In fact, Mexico was a net exporter to the United States. A 20 percent decline in production costs for Canada and Mexico (Model 8) further declines U.S. production and increases production in both Canada and Mexico. The United States exports no broiler meat to Mexico and virtually none to Canada. Both Canada and Mexico are net exporters to the United States. A 20 percent decline in production costs would allow several producing regions in Canada and Mexico to be more competitive than U.S. broiler producers.

Production capacity is doubled at Fargo (Model 9) to determine if two standard sized processing facilities can be supported in North Dakota. Results indicate Fargo uses all of its production capacity and, therefore, could support two processing facilities. Fargo's exports to Canada increase from 2.19 mpd (Model 1) to 18.08 mpd (Model 9).

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