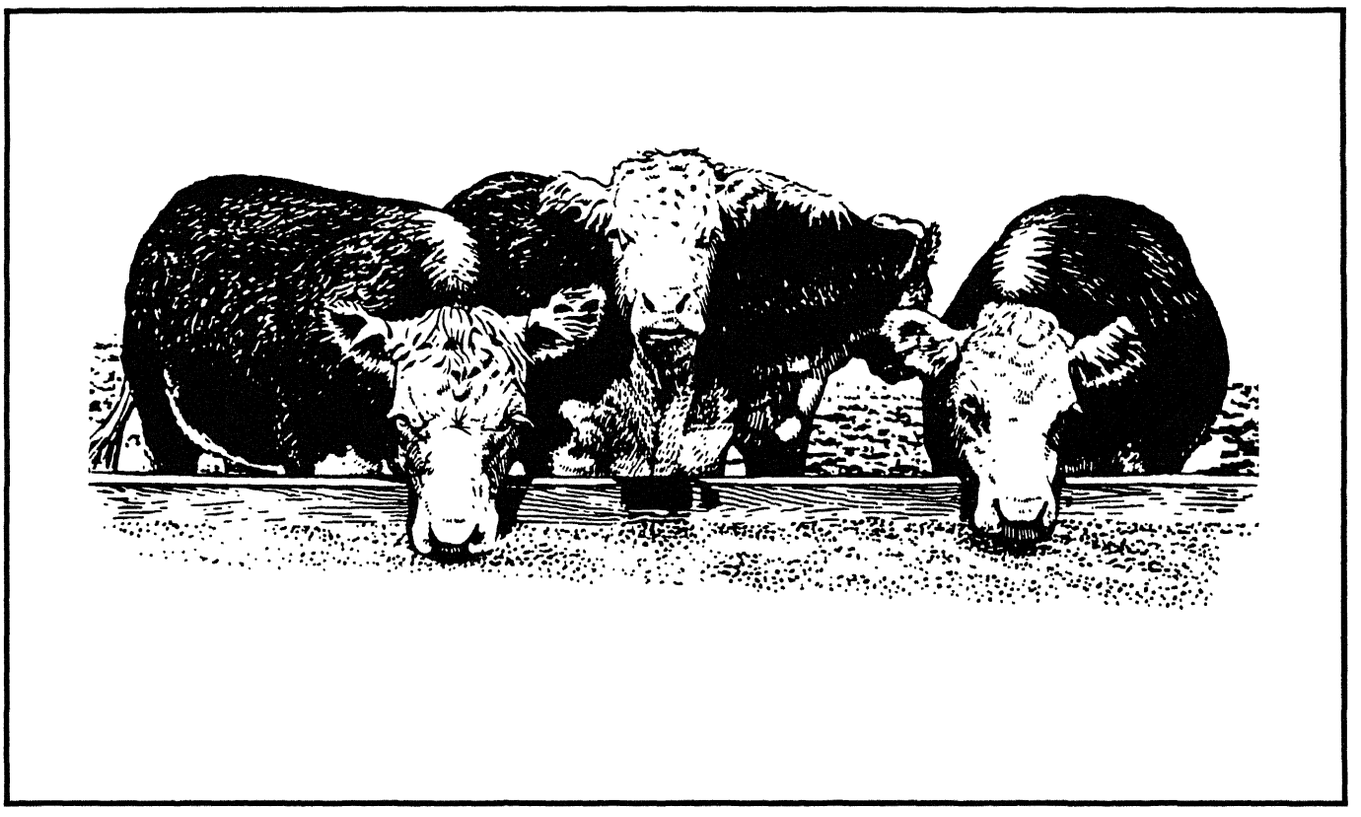
U.S. and Canada FTA: Implications for U.S. Regional Red Meat and Grain Markets



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The Ohio State University
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Thomas Worley and E. Dean Baldwin

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For Southern Regional Project S-231

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U.S. and Canada FTA: Implications for U.S. Regional Red Meat and Grain Markets

Thomas Worley and Dean Baldwin[1]

Introduction

The General Agreement on Tariffs and Trade (GATT) was established in 1947 to reduce trade impediments among participating nations. Agricultural trade was largely excluded from GATT discussions until the Uruguay round of negotiations. The exclusion of agricultural trade from prior multilateral talks was due to member nations' desire to protect domestic agricultural industries from international competitive forces (Deaton *et al.* 1990) and (Gleckler and Tweeten 1990). GATT members not only maintained existing barriers to global agricultural trade, but expanded the use of restrictive agricultural trade policies. Bilateral trade relations between the United States and Canada, with respect to agricultural products, were not immune to this proliferation of protective trade regulations.

Agricultural trade between the United States and Canada is influenced by numerous trade barriers arising from long histories of agricultural market interventions. Although selective benefits were achieved with these control policies, restrictive trade tactics caused economic inefficiencies in both countries. U.S. exports of agricultural products to Canada and the rest of the world have been limited by these same protective trade policies.

Canada and the United States ultimately acknowledged the problems arising from trade barriers and sought to reduce them through negotiation of a bilateral Free Trade Agreement (FTA; U.S.-Canada FTA). Negotiations for the FTA began in 1985 and became law in both nations in 1989. In essence, the FTA eliminates bilateral tariffs within 10 years under one of three alternative time schedules (Normile and Goodloe 1988). Furthermore, the agreement provides the institutional framework for further reductions in non-tariff trade restrictions not specifically addressed in the agreement.

Chapter Seven of the FTA embodies the provisions that liberalize trade for grains, livestock, and the products thereof. Both countries agreed not to impose or reimpose quantitative restrictions on grain or grain products as long as domestic support levels in each nation remain unchanged. Canada agreed to abolish transportation subsidies for grain and oilseed exports to U.S. West Coast ports. Furthermore, for livestock and meat products, the two nations agreed on three points: (1) to exempt each other from their respective meat import laws; (2) to work toward eliminating subsidies and countervailing duties (CVD); and (3) to develop joint health and packaging regulations that both minimize trade restrictions and protect the health of humans, animals, and plants.

Eliminating tariffs and other trade barriers for grains, livestock, and red meat should enhance economic welfare in both nations, which is the ultimate goal of the FTA. Theoretically, improved welfare is expected because each nation can increase its specialization in the production and processing of grain and livestock products for which it has a comparative advantage and market the increased output to the other nation. Real-sector theory of international trade as identified by Smith, Ricardo, and Heckscher-Ohlin is the foundation for the expected specialization and welfare gains (Salvatore 1987).

Problem Identification

Liberalized agricultural trade is expected to enhance overall welfare in both nations by making the production and marketing of food more efficient. However, all regions and industries cannot expect to benefit in a free-trade environment. Implementation of the FTA will benefit those industry groups and geographic regions in both nations which are most cost competitive, while those groups which are least competitive may experience economic losses in the transitional short-run period.

Added competition through the FTA may cause some groups of individuals and geographic regions to face adverse effects of resource allocations. Labor and other resource transfers between industries and regions involve costs to these groups. Displaced workers are

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faced with retraining and relocation in order to participate in those industries and regions which experience growth as a result of expanded marketing opportunities. Reallocation of land to new uses also involves costs to landholders and central governments.

The grain and livestock industries of the United States and Canada are widely dispersed geographically and represent large investments in production, processing, transportation, and marketing facilities. Levels of production, transport patterns, processing centers, and consumption of these commodities among regions may be altered. These changes may follow differing paths through time; therefore, it is important to realize the separation between short- and long-run impacts of the FTA.

Regional concentrations of grain and livestock production may shift due to altered trade opportunities. The effect on regions of the United States is of interest due to possible shifts within the competitive balance between traditional grain and livestock production regions. Hog production and processing in the southeastern United States could decline if expanded supplies of low-cost grain from Canada become available to expand livestock production and processing for export to the United States. Crop enterprise mixes could be altered within the United States due to changes occurring in Canada. Shipping patterns within the United States could thus be changed significantly due to eventual free flows of grain and livestock products in north-south corridors across the U.S. and Canadian border.

Assessing the impact of U.S.-Canada trade liberalizations is complicated by the presence of politically active industry organizations in both nations. Their influence is likely to prevail upon the success of various binational panels which may be formed to handle dispute settlements arising from the agreement. The introductory trade liberalizations may not significantly change the trade patterns between the two countries; therefore, producer, processor, and consumer groups may not become politically active during the early stages of the FTA.[1] However, as trade barriers are further reduced over time and trade patterns change in response to the freer-trade regimes, political resistance to specific future liberalizations may surface in either country. The existence of such groups could result in the failure to achieve the long-range goal of free United States-Canada agricultural trade.

Although both the red meats/livestock and grain sectors are of major importance to the two countries, the actual magnitude and distribution of the gains and losses for U.S. and Canadian grain and livestock sectors and regions have not been quantified. Instead, much of the published FTA agricultural research literature is theoretical, descriptive, and/or qualitative in nature (Carter 1988), (Guither 1987), (Normile and Goodloe 1988), (Schott and Smith 1988), (Schmitz *et al.* 1986), (Schuh 1988), and (Warley and Barichello 1986).

Additionally, there is a lack of information concerning the magnitude of the consumer/producer tradeoffs precipitated by this trade liberalization. Schuh points out that trade liberalization between developed nations involves tradeoffs between domestic producers and consumers, with consumers expected to benefit at the expense of producers (Schuh 1988).

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[1]See End Notes on page 31.

Objectives

This bulletin focuses on consumer/producer welfare issues and the FTA's effects on the red-meat/livestock and grain sectors for selected regions of the United States and Canada. Consumer and producer welfare effects of progressively freer U.S.-Canada trade arising from changes in production, processing, and trade-flow patterns of pork, beef, hogs, cattle, corn, soybeans, wheat, barley, and canola in designated geographic regions of the United States and Canada are analyzed. Specific objectives are to:

a. Compile secondary consumption, production, processing, transportation, and marketing data for the specified commodities in order to identify regional concentrations and relative costs.

b. Describe the trade barriers which currently exist and incorporate them into the mathematical model.

c. Use mathematical programming techniques to model and analyze the production, processing, transportation, and consumption activities of the specified grain and livestock commodities on a regional basis for the United States and Canada under the following trade-policy environments:

1. Pre-FTA trade policy: 1987 is the base year for comparison of subsequent policies.
2. Free Trade Agreement Policy: Initial 1989 provisions.
3. Comprehensive FTA Policy: All trade barriers removed simultaneously with three producer subsidy equivalent scenarios.
4. Sequential FTA Policy: Phase out of trade barriers over time with

two producer subsidy equivalent scenarios.

The producer subsidy equivalents were included in the analysis to provide a method to introduce the many forms of policy interventions. The definition for the upper, medium, and lower bounds subsidy levels are presented in the next section of this paper. For the 1989 provisions of the FTA, the sequential FTA phase-in policy, and the comprehensive FTA policy, changes are examined in the production, processing, and trade-flow patterns for market hogs and pork, fed cattle and beef, corn, soybeans, canola, wheat, and barley. The results for the three scenarios are compared to the pre-FTA environment.

Theoretical and Quadratic Programming Models

The effects of the FTA on producer and consumer welfare were determined for seven U.S. production and consumption regions, two Canadian regions, and for the two countries as a whole. Long-run competitive equilibrium is modeled for the two nations using quadratic programming methods.

Aggregate red meat output and prices in the United States and Canada are assumed to be related by linear demand functions. The derived consumer demand for red meat and stipulated meat processing coefficients endogenously determine the meat processing capacity and the number of fed cattle and market hogs produced by regions. Since the effects of the FTA are being modeled for a long-run time period, it is assumed that each region and nation can adjust its meat processing and livestock production capacities; both industry supply functions are perfectly elastic; and both industries are operating at the lowest point on the long-run average cost curves. Thus, quasi-rents or returns to fixed factors owned by meat processors and livestock producers are not measured by the model.

Selected grain demand functions are endogenously and exogenously determined for both nations. Demands for grain are derived from the endogenously determined fed cattle and market hog numbers and their respective feeding rations. Grain demands for export, processing, and other livestock and poultry (non-red meat) feeds are exogenously determined at the 1987 base-year levels for both nations. It is assumed that grain producers are operating at the lowest point on their long-run average cost curves, and the maximum volume of grain produced in each region is a function of the available acreage and reported 1987 yields. Thus, the grain supply functions in each region are perfectly elastic until the acreage limit is approached. Quasi-rents or returns to the fixed-factor land are measured by the model.

Based on the requirements of the different FTA scenarios, meats, livestock, and grains may be transported from all supply regions to all demand regions in the two nations. Since it is assumed that there are no transportation constraints and transportation rates are fixed, all transportation supply and demand functions are perfectly elastic and endogenously determined.

U.S. - Canada Free Trade Model

The mathematical model used in this analysis is formulated as follows:

$$\text{Max. } Z = \sum_j \sum_m \int_0^{MD^*_{mj}} P_{mj}\, dMD_{mj} - \sum_i \sum_r \sum_m CLR_{mri}\, LR_{mri} \qquad [1]$$

$$- \sum_k \sum_m CLP_{mk}\, LP_{mk} - \sum_k \sum_i \sum_m CLX_{mik}\, LX_{mik}$$

$$- \sum_j \sum_k \sum_m CMX_{mkj}\, MX_{mkj} - \sum_i \sum_g CGR_{gi}\, GR_{gi}$$

$$- \sum_j \sum_d \sum_i \sum_g CGX_{gidj}\, GX_{gidj}$$

$$- \sum_j \sum_i \sum_g CFX_{gij}\, FX_{gij}$$

Subject to the constraints:

$$\sum_g GR_{gi} \leq \bar{AC}_i, \qquad [2]$$

$$GR_{gi}\, Y_{gi} = \sum_j \sum_d GX_{gidj} + \sum_j FX_{gij}, \qquad [3]$$

$$\sum_i GX_{gidj} = \bar{GD}_{gdj}, \qquad [4]$$

$$\sum_r \sum_m FR_{gmri}\, LR_{mri} = \sum_i FX_{gij}, \qquad [5]$$

$$\sum_r LR_{mri} = \sum_k LX_{mik}, \qquad [6]$$

$$LP_{mk} = \sum_i LX_{mik}, \qquad [7]$$

$$LP_{mk}\, DP_{mk} = \sum_j MX_{mkj}, \qquad [8]$$

$$\sum_k MX_{mkj} = MD_{mj}. \qquad [9]$$

Where

Z is the aggregate measure of quasi pork and beef consumer surplus

$P_{mj}=\alpha_{mj} - \beta_{mj} MD_{mj}$ is the demand function for meat m in region j

MD^*_{mj} is the equilibrium quantity of meat m demanded in region j

C is the per-unit cost associated with each corresponding activity defined here

LR_{mri} is the number of head of livestock m raised on ration r in region i

LP_{mk} is the number of head of livestock m processed in region k

LX_{mik} is the number of head of livestock m transported from production region i to processing region k

MX_{mkj} is the number of pounds of meat m transported from processing region k to meat demand region j

GR_{gi} is the number of acres of grain g raised in crop production region i

GX_{gidj} is the number of bushels of grain g transported from production region i to exogenous grain and other livestock demand d in region j

FX_{gij} is the number of bushels of feed grain g transported from grain production region i to livestock production region j.

AC_i is the fixed number of acres of cropland available in grain production region i

Y_{gi} is the per-acre yield in bushels of grain g produced in region i

GD_{gdj} is the fixed number of bushels of grain g demanded at exogenous demand type d in grain demand region j

FR_{gmri} is the number of bushels of feed grain g required to produce one head of livestock m, fed ration r, in production region i

DP_{mk} is the pounds of meat produced from processing one head of livestock m in processing region k.

When maximized, the objective function provides a measure of the aggregate level of quasi-welfare accruing to pork and beef consumers in the demand regions in the two nations.[2] The first term represents the total area under the demand functions. All the remaining negative terms are the summation of costs representing the underlying determinants of perfectly elastic aggregate supply functions for each commodity (Hazell and Norton 1986). Summing these costs and subtracting their total from the first term in the objective function results in a measure of quasi consumer welfare.

Equation 2 indicates that the total acres of all crops in each region must sum to less than or equal to the total accessible acreage. The model has one such equation for each of the two Canadian and four U.S. grain-production regions. Quasi-rent or welfare accruing to producers is measured as the returns (shadow price of land) to the fixed factor (Hazell and Norton). Since this is the only fixed factor in the model, quasi-rent or producer welfare is measured as total returns to land owners.

Equation 3 states that the total quantity of each grain produced in a region (acres × yield) equals the total quantity of each grain shipped from the region to all possible demand regions. The demand regions consist of three exogenously set demands and the endogenously determined grain for feed demands. Similarly, Equation 4 states that the total quantity of grain shipped by all producing regions to each demand region must equal the quantity demanded. Equation 5 states that the total feed demand is the product of livestock feeding numbers and feed requirement per head of livestock produced.

The next four equations reflect the assumption that material balances between the livestock and meat regions will be maintained. Equation 6 ensures that the number of livestock produced in each region is equal to the total number shipped to all processing regions. Equation 7 states that the total head of each livestock processed in each processing region is equivalent to the total head of livestock shipped to the region by all production regions. Equation 8 indicates that the quantity of dressed livestock produced by each processing region is equal to the total meat shipments from that region to all demand regions. Equation 9 ensures the meat demand in each region is equal to the total quantity of meat shipments from all processing regions.

Solutions to the model provide the level of grain production by region and the number of livestock produced and processed in each region. The model also solves the transportation network among all producing, processing, and demand regions. The results for the transportation of commodities between regions of the two nations provide the international trade-flow information.

Measure of Consumer and Producer Welfare by Region

Beef and pork price and quantity coefficients were endogenously determined within the objective function for each optimal solution. For each demand region, these coefficients were entered into the following formula as a measure of consumer welfare for each region:

$$C.S._j = \sum_m \left(\alpha_m - \frac{1}{2}\beta_m Q_m^*\right) Q_m^* - P_m^* Q_m^*$$

P* and Q* are the optimal prices and quantities for pork and beef in region of demand j. α and β are the intercept and slope coefficients, respectively, of the demand functions for pork and beef. For each region and nation, the change in consumer surplus relative to the base model is reported.

For each grain production region, shadow prices for the fixed-factor, accessible crop-land acres are used to measure the marginal quasi-rent or producer surplus. Thus, the changes in producer welfare by region and nation are quantified relative to the base model as liberalized trade policies were introduced into the model.

Production and Consumption Regions, Data, and Pre-FTA Trade Restrictions for Base Model

The data used as objective function coefficients, right-hand side values, and physical transformation parameters were compiled from secondary sources published in the United States and Canada. In addition, expert opinions were used to supplement, verify, and support the secondary data. All model coefficients were calibrated to reflect economic conditions prevailing during base year 1987, a non-drought year prior to enactment of the U.S.-Canada Free Trade Agreement.

Three conventions were adopted and consistently applied throughout the data collection and transformation process. First, Canadian cost data were converted to equivalent costs in U.S. dollars at the average exchange rate for 1987 of $0.7541 U.S. dollar per Canadian dollar (Agriculture Canada). Second, Canadian data were converted to imperial units from the metric units which were used to report much of the data from the original Canadian sources. Third, relative cost differentials among geographic regions were estimated as opposed to precise determination of absolute cost levels. Every effort was made to determine and isolate variable resource and production techniques resulting in differentiated cost structures for activities among regions. Where no underlying difference in production technique could be discovered to justify regional cost differentials for an operation, the cost of performing the operation was assumed to be the same across all regions. Since the costs for several activities were judged equal across regions, the number of variable factors built into the analysis was reduced. This permitted more direct focus on regional characteristics bearing on trade flows.

Model Regions

Five U.S. livestock production regions were specified. Because 85 percent of U.S. hog production occurs in the North Central and Southeast regions, these two regions were identified as the U.S. hog-producing areas (Figure 1), (Hayenga *et al.* 1985) and (Van Arsdall and Nelson 1984). The North Central, Plains, and Western regions produce more than 75 percent of all U.S. fed cattle; therefore, these three regions were included in the model as beef feeding areas (Figure 2),(USDA, 1988).

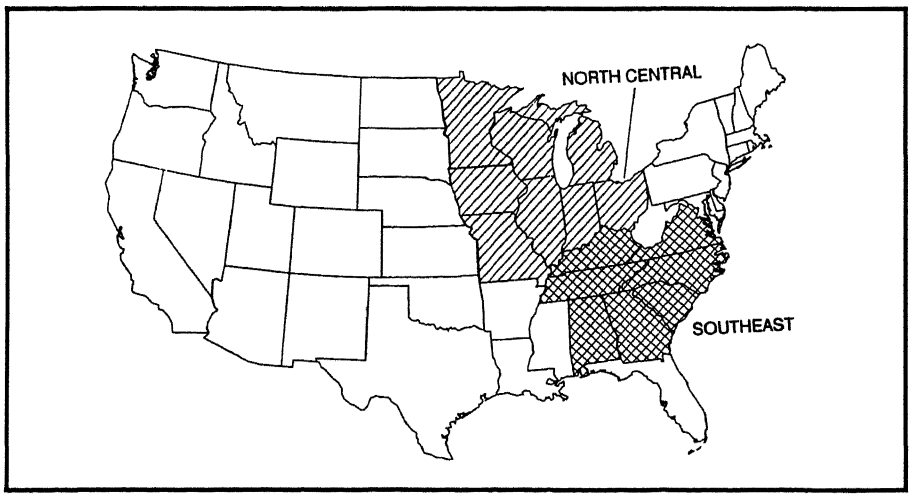
U.S. regions were defined for corn, soybean, and wheat production in the North Central, Southeast, and Plains regions (Figure 3), (USDA, 1988). Wheat production also was included in an additional U.S. region called "Local U.S. Wheat" to reflect the widespread pattern of wheat production across all regions of the United States. More than 95 percent of all U.S. production of the major grains occurs in the designated regions.

U.S. pork and beef demand regions were designated as the Northeast, Midwest, West, and South (U.S. Commerce Department 1989), (Figure 4). Exogenous grain demand points for export, domestic processing, and residual uses were specified for several regions in both nations based on data available for recent years (USDA 1988) and (Statistics Canada 1989).

All Canadian grain and livestock production, and pork and beef consumption, were divided into eastern and western regions as in previous Canadian studies (Martin and Zwart 1975) and (Moschini and Meilke 1987). Eastern Canada consists of Ontario, Quebec, and the Maritime Provinces. Western Canada is composed of the three prairie provinces and British Columbia.

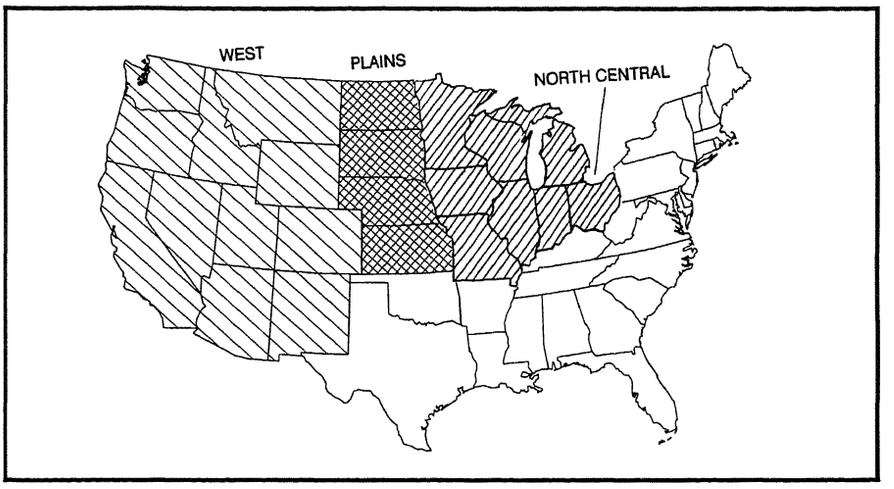
Objective Function Data

Prior to estimating regional costs for the livestock activities, multiple state and province production and processing cost data for hogs and cattle production were collected and compared (Illinois, Iowa, Ohio, Ontario, Manitoba, Alberta, USDA, AGR Canada, American Meat Institute). Analysis of these production and processing cost data revealed similar cost structures for livestock activities across all regions of the study. Further, experts concurred that similar livestock production and processing technologies exist in all regions (Van Stavern, Bunn, and West).

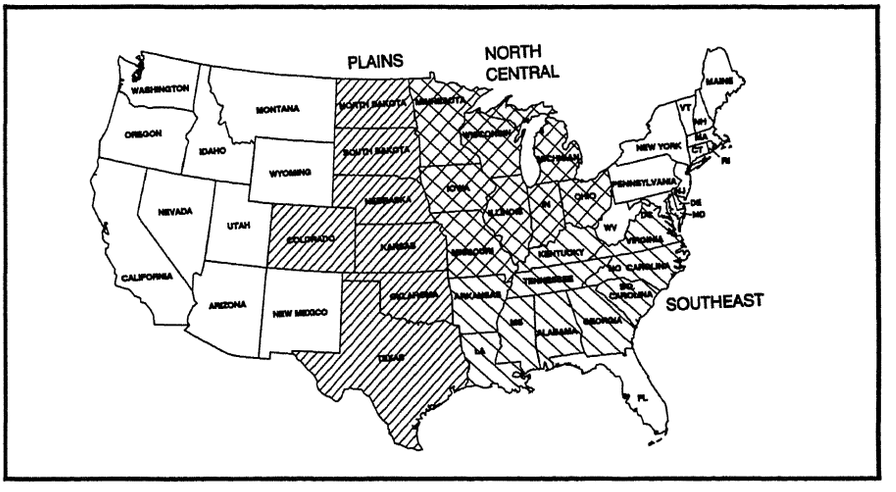


◄ **Figure 1.**
U.S. Hog Production and Processing Regions

► **Figure 2.**
U.S. Beef Production and Processing Regions



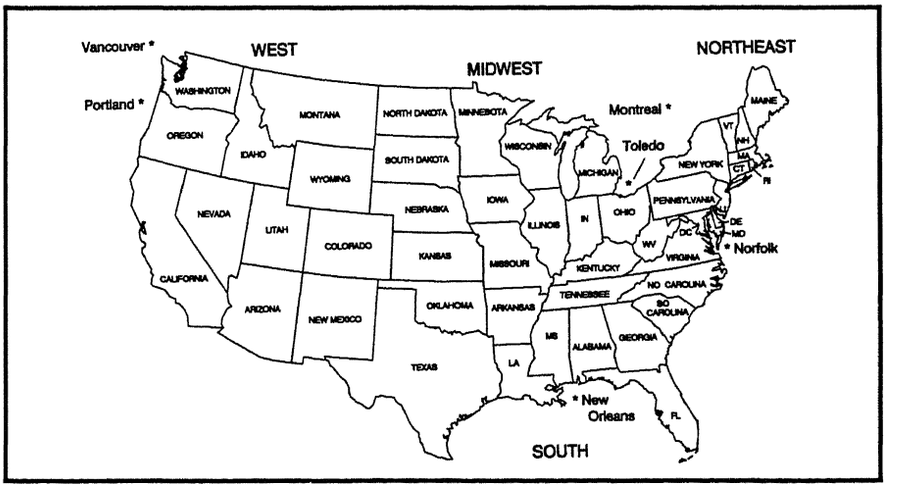
► **Figure 3.**
Grain Production Regions for the U.S.



► **Figure 4.**
Pork and Beef Demand Regions for the U.S., Grain Export Ports[1] and Exogenous Grain Demand Points[2]

[1] Grain Export Ports are designated with a *.

[1] One exogenous grain demand point is located within each region of the U.S. and in Western and Eastern Canada.



Based upon the similarity of cost data as reported by the states and provinces and the opinions of experts, it was assumed that livestock production and processing costs were invariable across regions (Appendix Table 1). These livestock production costs include all fixed and variable costs except the cost of feed grains required to finish feeder animals to slaughter weights. The feed requirements per head varied subject to alternative corn, barley, and wheat rations (Appendix Table 1). The feed requirements served as the model's linkages between the livestock and grain sectors. Thus, total feed grain requirements in each region were endogenously determined as a function of number of hogs and cattle produced.

Dressing percentages of hogs and cattle slaughtered were used as transformation coefficients in the processing activities of the model. These were assumed to average 74 and 55 percent for hogs and beef, respectively (USDA 1988) and (Agriculture Canada 1989).

All livestock and meat shipments were assumed to be made via truck. Costs of transportation for livestock and meat were specified as a function of distances between specified base cities within the regions (Appendix Tables 2 and 3). Per unit transport costs were calculated using a truck rate of $1.22 per mile (Hutchinson).

The intercept and slope parameters specifying linear demand functions for pork and beef regionally were derived from secondary sources (Seeley 1985), (Smallwood *et al.* 1989) and (Young 1987). These parameters were calculated by using price elasticities of demand reported by Smallwood and by Young for meat demand on a national basis and assuming regional demand proportional to consumption share (Appendix Table 4). The selected pork elasticity for both countries was −0.73 with a standard error of .0327. The selected beef elasticity and standard error for both countries was −0.61 and .0483, respectively.

Available acreage in each crop production region was collected from USDA and Agriculture Canada (Appendix Table 5). Crop yields reflect average yields during 1987 in each region. Variable costs of grain and oilseed production by region were compiled from numerous USDA, state, and provincial reports and were analyzed to specify consensus cost coefficients in the objective function (Iowa, Illinois, Indiana, Ohio, Manitoba, Alberta, Ontario, USDA), (Appendix Table 6). It was assumed that all regions had access to similar technologies. The cost of transporting grain among regions was based upon the distances between base cities within each region (Appendix Table 7).

Exogenous Quantities Of Grain Demanded

Grain supply and utilization data were obtained from USDA and Agriculture Canada publications (Appendix Table 8). These sources provided total use data for exports, processors, and residual demand including all livestock feed demand. Total U.S. export demand was allocated to the export demand regions defined earlier based upon previous work by the Southern Regional Committee on Grain Marketing which reported grain exports by port location (Fruin, Hallback, and Hill; Larson, Smith, and Baldwin; Reed and Hill). Canadian exports were allocated to the export regions based upon data provided by Agricultural Canada which reported exports by port city.

The residual demand reported by the supply and use publications was adjusted by deducting an estimated quantity of grain fed to pork and beef. The deduction was made based upon the quantity of feed fed to hogs and beef during 1987. The quantity required was calculated by multiplying the total head produced by the USDA estimates for the quantity required per animal produced (Wailes).

Producer Subsidy Equivalents

The 1987 base year producer subsidy equivalents (PSEs) as reported by USDA were used as proxies for government subsidy payments to grain producers (Appendix Table 9), (Webb, Lopez, and Penn). Only those payments to producers through direct income support programs were included for both nations. In Canada, these included payments under the Special Canadian Grains Program, Western Grains Stabilization Program, Agricultural Stabilization Act, Tripartite agreements, and crop insurance programs. In the United States, deficiency payments and land diversion payments are the main programs represented by the direct income support portion of PSEs. Inclusion of the PSE payments in the objective function of the model provided a method of introducing the many forms of policy interventions not specifically built into the model.

The portion of the PSEs associated with policies impacting variable costs of production were excluded from the analysis because these subsidies were captured in the cost of production data. Price intervention subsidies, including the two price systems for Canadian wheat and the U.S. price-enhancing policy, were also excluded because these subsidies constitute a relatively small percentage of the total PSEs and their effects may be captured in the model's implicit grain prices.

Trade Restrictions

The base model representing 1987 conditions of trade between the United States and Canada contained the following modifications to its parameters to represent the trade restrictions then in place. These were (1) tariff and countervailing duty restrictions; (2) quantitative restrictions embodied by import licenses and Section 22 authority; and (3) Canadian transportation subsidies. The methods used to incorporate these restraints into the model are presented here.

U.S.-Canadian Tariffs And Countervailing Duties

The U.S. and Canadian tariff rates applicable to the commodities included in the study are presented in Appendix Table 10. Similar tariff rates are charged in both nations for wheat, barley, oilseeds, and beef. The Canadian countervailing duty (CVD), $0.64 per bushel on U.S. corn imports, represents the largest single tariff barrier to imports from the United States. The U.S. CVD on Canadian hog shipments of $0.038 per pound is the largest single tariff barrier to U.S. hog imports from Canada. These tariffs were added to the respective transportation costs for commodity shipments between the two nations.

Canadian Non-Tariff Barriers

Import licenses issued by the Canadian Wheat Board for wheat and barley imports have been the most important non-tariff barrier to imports of these grains from the United States. These licenses are granted by the External Affairs Board for wheat and barley only when domestic supplies are deemed to be inadequate. Since large surpluses of these commodities are produced in Canada, import licenses have rarely been issued. Rapeseed, corn, and soybeans are relatively unencumbered by Canadian non-tariff barriers although the CVD on corn may be a limiting factor for corn imports from the United States.

Live hogs are subject to a 30-day quarantine upon arrival in Canada in the interest of keeping Canada's swine herd free from pseudorabies, a disease still evident in some U.S. hogs. This requirement completely eliminates U.S. slaughter hog shipments to Canada. The model activities for live-hog transport from U.S. production regions to Canadian processing regions were fixed at zero levels to reflect these quarantines. Live cattle are required to have a veterinarian's health certificate verifying the condition of the cattle. Pork and beef from the United States are relatively free to move into Canada subject only to health inspections. Thus, shipments of pork and beef were not restricted in the model.

United States Non-Tariff Barriers

The United States threatens the limitation of imports of any grain being supported by government programs. This threat is in the form of Section 22 of the Agricultural Adjustment Act of 1933. Section 22 authorizes the imposition of quotas on the import of any commodity which threatens to interfere with the operation of commodity support programs in the United States. This is considered to be the limiting barrier to U.S. imports of Canadian wheat, barley, corn, and soybeans. Currently, the import of canola from Canada is not subject to barriers as a result of this authority.

Slaughter hogs and cattle imports from Canada are subject to health certification requirements which are similar to those for U.S. shipments. However, there is no quarantine restriction on Canadian hogs as exists in Canada. Pork and beef imports from Canada are subject to U.S. inspections, labeling requirements, chemical residue tests, and grading standards.

Base Model Results

All data and trade restrictions outlined in the previous section were incorporated into the U.S.- Canada model to obtain the base solution. The base model was validated by determining (1) how accurately the results replicated the respective regions' production, marketing, and trade levels for the base year (1987); (2) whether the base period beef and pork demand quantities and prices were replicated; (3) whether the model reproduced fed cattle, market hogs, and grain quantities by region; and (4) whether the optimal solution was sensitive to a change in the beef and pork demand elasticities (McCarl and Spreen).

The outcomes from the model were accepted as valid. Differences between the endogenously determined model results and published data in most cases varied by approximately five percent (Worley 1989). For regions where reported livestock or grain production levels were relatively small, differences between the two sets of results were as high as 10 percent. The sensitivity results, in which the demand elasticity coefficients were changed by plus and minus one standard error around the originally assumed point elasticity estimates for pork and beef demands, were not modified relative to the base solution. However, and as expected, the objective function values were modified. For these reasons, the base-model results reported in Tables 1 to 5 were accepted as valid benchmarks for comparing outcomes generated for the trade liberalization scenarios.

U.S. Regional Markets

The base model results indicated total U.S. beef production of 23.2 billion pounds compared to 23.6 billion pounds actually produced in 1987 (Table 1 and USDA). Beef production in the United States was concentrated in the North Central region; more than 19 million pounds of beef were produced in the base model. Beef was shipped from the North Central region to the Northeast, Midwest, and South. The Plains region produced 4.2 billion pounds of beef, all of which was shipped to the western United States.

Pork production in the United States was also concentrated in the North Central region (Table 2). Twelve billion pounds were produced and shipped to Canada and to the West, Midwest, and South regions in the United States. In the model, the southeastern United States produced nearly 1.8 billion pounds of pork. Most was shipped to the northeastern United States with the remainder being shipped to consumption centers in the South. Regional production levels and shipment patterns within the basic solution are consistent with those

Table 1. Regional Shipments of Processed Beef for a Base Model and Freer Trade Scenarios

	Model Solutions						
		FTA	Comprehensive FTA Scenarios			Sequential (Phase-in) FTA	
Regional Shipments[1]	Base	1989 Provisions	Upper Bound Subsidy[2]	Medium Subsidy Level[3]	Lower Bound Subsidy[4]	1987 Subsidy Level[5]	Medium Subsidy Level[3]
			— — — — (000,000 lbs.) — — — —				
NORTH CENTRAL to:							
Eastern Canada	0	0	0	0	911.7	1718.6	1707.4
Western Canada	0	0	0	0	0	691.1	686.7
Northeast	4919.5	3434.9	1946.3	5482.7	5430.7	5219.2	5182.0
Midwest	8298.5	8301.5	9341.5	9243.0	9155.8	8801.1	8738.8
South	5832.4	5834.5	6568.6	6499.1	3900.6	6187.2	6143.2
TOTAL	19050.4	17570.9	17856.4	21224.8	19398.8	22617.2	22458.1
PLAINS to:							
West	4246.8	4245.6	5502.1	5443.6	0	5181.1	5144.1
South	0	0	0	0	2536.9	0	0
TOTAL	4246.8	4245.6	5502.1	5443.6	2536.9	5181.1	5144.1
EASTERN CANADA to:							
Eastern Canada	1633.9	1631.6	1817.6	1799.7	870.4	0	0
Northeast	0	1486.3	3595.2	0	0	0	0
TOTAL	1633.9	3117.9	5412.8	1799.7	870.4	0	0
WESTERN CANADA to:							
Western Canada	663.6	660.6	732.4	727.1	772.4	0	0
West	635.7	638.7	0	0	5393.3	0	0
TOTAL	1299.3	1299.3	732.4	727.1	6165.7	0	0

[1]Total regional processed beef shipments are converted to live-head equivalent using a factor of 662 pounds of processed beef equals one head.
[2]The upper bound subsidy represents a harmonization plan in which both countries equate their subsidies for respective commodities at the maximum rate paid to producers by either country in 1987.
[3]The medium subsidy level represents a harmonization plan in which both countries equate their producer subsidies for respective commodities at the minimum rate paid to producers by either country in 1987.
[4]The lower bound subsidy represents a harmonization plan in which both countries equate their subsidy rates for all commodities at zero dollars.
[5]Producer subsidies for the respective commodities and countries are not changed from the 1987 levels (harmonization does not occur).

observed for the 1987 base year (Worley).

In the base model, corn, soybeans, and wheat were produced in the North Central, Southeast, and Plains regions (Table 3). Wheat was also produced in the Local U.S. Wheat region, and barley was produced in the Plains. More than 60 percent of all acres were planted to soybeans in the Southeast with the remaining acres being planted to corn and wheat.

U.S.-Canada Trade

The only trade between U.S. and Canadian regions in the base model took place in pork and beef. Pork from eastern Canada was shipped to the Northeastern U.S. market while North Central pork was transported into western Canada. Beef from western Canada flowed into the western region of the U.S. In 1987, both live animals and meat were traded between the two countries. After converting the live animals to a carcass weight equivalent, the net trade for 1987 was 190.5 million

Table 2. Regional Shipments of Processed Pork for a Base Model and Freer Trade Scenarios

	Model Solutions						
		FTA	Comprehensive FTA Scenarios			Sequential (Phase-in) FTA	
Regional Shipments[1]	Base	1989 Provisions	Upper Bound Subsidy[2]	Medium Subsidy Level[3]	Lower Bound Subsidy[4]	1987 Subsidy Level[5]	Medium Subsidy Level[3]
				(000,000 lbs.)			
NORTH CENTRAL to:							
Eastern Canada	0	0	0	0	0	1313.8	1302.5
Western Canada	491.6	491.9	0	0	0	528.4	523.8
West	3020.3	3021.7	1545.3	3491.0	3448.3	3271.2	3240.1
Northeast	0	1279.0	0	3501.1	3480.8	0	0
Midwest	5160.7	5163.2	6037.4	5954.6	5881.3	5583.2	5530.8
South	3359.9	3621.4	0	4179.9	4128.1	2266.3	2356.7
TOTAL	12032.5	13577.2	7582.7	17126.6	16938.5	12962.9	12953.9
SOUTHEAST to:							
Northeast	1513.9	1773.6	3583.0	0	0	3311.7	3280.5
South	259.7	0	4238.9	0	0	1651.4	1524.1
TOTAL	1773.6	1773.6	7821.9	0	0	4963.1	4804.6
EASTERN CANADA to:							
Eastern Canada	1228.3	1226.1	1414.6	1396.5	1378.5	0	0
Northeast	1545.9	0	0	23.4	0	0	0
TOTAL	2774.2	1226.1	1414.6	1419.9	1378.5	0	0
WESTERN CANADA to:							
Western Canada	0	0	573.3	564.4	556.9	0	0
West	0	0	1995.8	0	0	0	0
TOTAL	0	0	2569.1	564.4	556.9	0	0

[1]Total regional processed pork shipments are converted to live head equivalent using a factor of 178 pounds of processed pork equals one head.
[2]The upper bound subsidy represents a harmonization plan in which both countries equate their subsidies for respective commodities at the maximum rate paid to producers by either country in 1987.
[3]The medium subsidy level represents a harmonization plan in which both countries equate their producer subsidies for respective commodities at the minimum rate paid to producers by either country in 1987.
[4]The lower bound subsidy represents a harmonization plan in which both countries equate their subsidy rates for all commodities at zero dollars.
[5]Producer subsidies for the respective commodities and countries are not changed from the 1987 levels (harmonization does not occur).

pounds of beef in favor of Canada compared to the model's derived shipment of 635.7 million pounds of beef. Pork trade was also of the correct direction in the model with a net trade of 1,545.9 million pounds from Canada. In 1987, the net flow of pork was 505 million pounds, a difference of 1,041 million pounds.

Free Trade Agreement Model (1989 Provisions)

The base model coefficients were modified to reflect the 1989 provisions of the U.S.-Canada Free Trade Agree-

Table 3. Regional Grain Production for the Base Model and Freer Trade Scenarios

	Model Solutions						
		FTA	Comprehensive FTA Scenarios			Sequential (Phase-in) FTA	
Regional Grain Production	Base	1989 Provisions	Upper Bound Subsidy[1]	Medium Subsidy Level[2]	Lower Bound Subsidy[3]	1987 Subsidy Level[4]	Medium Subsidy Level[2]
			(000,000 acres)				
NORTH CENTRAL							
Corn	34.64	34.64	32.03	39.74	36.70	39.04	38.22
Soybeans	39.64	39.64	43.51	42.26	41.69	35.24	36.06
Wheat	6.16	6.16	6.16	6.47	10.08	6.16	6.16
SOUTHEAST							
Corn	4.31	4.31	9.82	2.70	2.7	7.22	7.07
Soybeans	13.67	13.67	13.67	13.67	13.60	13.67	13.67
Wheat	4.78	4.78	1.55	6.33	4.87	1.88	2.02
PLAINS							
Corn	12.63	12.63	12.63	12.63	12.63	12.63	12.63
Soybeans	6.65	6.65	3.55	3.55	4.23	6.65	6.65
Wheat	32.43	32.43	33.45	31.49	28.98	37.43	36.75
Barley	8.89	8.89	10.27	8.62	7.78	3.89	4.57
LOCAL U.S. WHEAT							
Wheat	10.54	10.54	11.59	11.59	11.59	10.54	12.54
EASTERN CANADA							
Corn	4.19	4.19	5.91	3.40	2.73	0	0.78
Soybeans	1.19	1.19	0	1.19	1.19	5.38	4.60
Barley	0	0	0	1.33	2	0	0
WESTERN CANADA							
Wheat	35.08	35.08	38.90	32.18	30.85	33.23	33.83
Barley	8.89	8.89	10.12	7.33	17.97	10.74	10.14
Canola	6.52	6.52	6.52	6.52	6.52	6.52	6.52

[1]The upper bound subsidy represents a harmonization plan in which both countries equate their subsidies for respective commodities at the maximum rate paid to producers by either country in 1987.
[2]The medium subsidy level represents a harmonization plan in which both countries equate their producer subsidies for respective commodities at the minimum rate paid to producers by either country in 1987.
[3]The lower bound subsidy represents a harmonization plan in which both countries equate their subsidy rates for all commodities at zero dollars.
[4]Producer subsidies for the respective commodities and countries are not changed from the 1987 levels (harmonization does not occur).

ment. The modifications included elimination of regular tariff rates on grain, livestock, and meat shipments between regions of the two nations. In addition, Canadian transport subsidies on grain shipments originating in western Canada bound for destinations in the demand regions of the United States were withdrawn.

FTA Model Results

The FTA provisions caused some additional specialization to occur in the livestock regions of eastern Canada and in the North Central U.S. production regions. Eastern Canada became more specialized in the production and processing of fed cattle at the expense of hog production. In contrast, the North Central U.S. production region concentrated on hog production and processing in place of cattle production (Tables 1 and 2). The additional fed cattle production was processed into beef within eastern Canada for shipment to the Northeast beef demand region of the United States. The added North Central pork production was shipped to the Northeastern pork demand region in place of shipments from eastern Canada in the base model.

Total hog production for the Southeast region in the FTA model solution was unchanged from base-model levels. The pattern of pork shipments from Southeast processors was altered, however. All pork shipments from the Southeast were destined for the Northeast region in the FTA solution in contrast to some shipments to the South in the base model. The change amounted to 259.7 million pounds of pork shipments to the Northeast in place of like shipments to the South consumption region. The shipments formerly made by the Southeast were made by the North Central region as an outlet for the region's increased pork production.

In contrast to the observed changes in the livestock sectors, regional grain production, processing, and transportation activities were not modified from the base-model levels (Table 3). These findings are consistent with those reported by Carter. Changes in livestock production had no effect on grain shipments because the adjustments in livestock numbers were made in such magnitude that the total corn required for feed in both the North Central United States and eastern Canadian regions remained equal even though different numbers of hogs and cattle were being produced.

Producer and Consumer Welfare Changes

Total consumer surplus for both nations increased by only $660 thousand (Table 4). For both Canadian regions, consumer surplus declined marginally because beef and pork prices each increased by one-half cent per pound in eastern Canada, and beef prices increased two cents per pound in western Canada relative to the base model. The decline in consumer surplus in the Northeastern U.S. region resulted from an approximate three-quarters of a cent per pound increase in pork price relative to the base model. Consumer surplus increased in all other U.S. regions because pork and beef prices declined by, at most, one-quarter cent per pound. These findings are consistent with spatial equilibrium theory. Beef price increased in the region where increased flows originate (eastern Canada), while beef price declined in the destination region (Northeastern U.S.).

As a result of these price changes, weighted average producer welfare increased by $1.41 and $9.33 per acre, respectively, for the United States and Canada (Table 5). In contrast to the weighted averages, producer welfare declined for two U.S. regions, the North Central and Local U.S. Wheat. Producer welfare decreased in the North Central region because the expanded use of grain for hog production contributed less to land values than did the displaced use of grain for beef cattle production. Concomitantly, the value of wheat production for the local U.S. region declined, precipitating a decline in the marginal value of land in this region. Although the producer and consumer welfare changes are extremely small, the findings are consistent with Schuh's prediction of gain for consumers at the expense of some producers.

Comprehensive FTA Policy: Elimination Of Trade Barriers At One Time

As suggested by Carter, the short-run provisions of the FTA did not phase out many of the important agricultural trade barriers that exist between the United States and Canada. In the future, negotiators could eliminate all remaining trade barriers at one time (comprehensive FTA policy), or some barriers could be eliminated over time (sequential FTA policy). The latter, the phase-in process, is similar to current provisions of the Free Trade Agreement, a phase-in policy that may result in the substitution of one set of economic distortions for another set of distortions.

To assess the effects of a comprehensive FTA policy, three additional trade restrictions were removed, and domestic price support and acreage control programs were harmonized or

deleted to achieve a free-trade environment consistent with Heckscher-Ohlin comparative advantage assumptions. The three trade restrictions removed were: (1) Canadian import license requirements for U.S. wheat and barley exports and the U.S. Section 22 quota threats (the removal of these licenses and quota threats is a provision of the FTA when domestic support levels are equal) on Canadian grain, (2) the U.S. countervailing duties (CVD) on imports of Canadian hogs and pork and the Canadian countervailing duty on imports of U.S. corn, and (3) the rail transportation subsidies for western Canadian grain shipments.

Harmonizing direct income subsidies and acreage control programs is a major challenge for the trading partners because it is difficult to determine which subsidies have trade distorting effects [Schmitz]. Since there is not a specific plan to harmonize the direct income subsidy programs at this time, three different subsidy scenarios were analyzed. The first, which was assumed to be an upper bound subsidy case, represents a harmonization plan in which both countries equated their producer subsidies for the respective commodities at the maximum rate paid to producers by either country in 1987. Except for oilseeds, the 1987 U.S. subsidy levels paid to farmers were higher than for Canada (Appendix Table 9). Thus, the upper bound subsidy case incorporated all U.S subsidies except for oilseeds.

For the medium subsidy case, it was assumed that the two countries would equate their producer subsidies for the respective commodities at the minimum rate paid to producers by either country in 1987. With the exception of oilseeds, the relatively lower Canadian subsidies were incorporated into the model. The lower bound subsidy case was a harmonization plan in which it was assumed that both countries agree to a zero dollar subsidy level for all commodities.

Harmonizing the acreage control programs was simulated by increasing

Table 4. Change in Consumer Surplus by Region for Freer Trade Scenarios Relative to Base Model

	Model Solutions						
		FTA	Comprehensive FTA Scenarios			Sequential (Phase-in) FTA	
Region	Base	1989 Provisions	Upper Bound Subsidy[1]	Medium Subsidy Level[2]	Lower Bound Subsidy[3]	1987 Subsidy Level[4]	Medium Subsidy Level[2]
			— — — — (000,000) — — — —				
CANADA							
East Canada	0	−16.23	1407.81	1263.07	1121.84	626.67	542.08
West Canada	0	−11.71	565.73	510.62	464.1	231.17	197.13
TOTAL	0	−27.94	1973.54	1774.32	1585.94	857.84	739.21
U. S.							
West	0	10.6	3981.6	3582.9	3239.9	1852.0	1615.7
Northeast	0	−12.5	4020.0	3589.4	3237.2	1869.5	1631.0
Midwest	0	17.9	6775.5	6097.3	5503.1	3152.7	2750.6
South	0	12.6	4761.7	4283.3	3865.8	2214.5	1932.0
TOTAL	0	28.6	19538.8	17552.9	15846.0	9088.7	7929.3
Change Overall Consumer Surplus	0	0.66	21512.34	19327.22	17431.94	9946.54	8668.51

[1]The upper bound subsidy represents a harmonization plan in which both countries equate their subsidies for respective commodities at the maximum rate paid to producers by either country in 1987.
[2]The medium subsidy level represents a harmonization plan in which both countries equate their producer subsidies for respective commodities at the minimum rate paid to producers by either country in 1987.
[3]The lower bound subsidy represents a harmonization plan in which both countries equate their subsidy rates for all commodities at zero dollars.
[4]Producer subsidies for the respective commodities and countries are not changed from the 1987 levels (harmonization does not occur).

cropland acreage by 10 percent above base levels in all grain production regions in the model.[3] Agricultural programs were responsible for acreage reductions in U.S. regions of approximately 10 percent for 1987. These reductions were largely due to ARP provisions of the 1985 farm program.

Comprehensive Model Results

Increasing the available crop acreage resulted in some fallow land, or land that was in the slack activities of the model for all three solutions.[4] When the direct income subsidies were at the assumed upper subsidy bounds, nearly seven million acres of fallow land for both the U.S. North Central and Plains regions were in the solution generated by the model. The model, with the assumed medium subsidy levels, forced 2.3 million acres in the Southeast, 10.4 million acres in the Plains, and 9.5 million acres in western Canada into slack activities. For the assumed lower bound subsidy model, the Southeast and Plains regions of the United States and the western region of Canada had 13, four, and one million acres, respectively, in slack activities.

These acres were unused in all three cases because the models reached a maximum level of consumer surplus in the respective objective functions that could not be increased by more meat consumption. These maximums were attained when the total per pound cost of supplying extra pounds of pork and beef to the demand regions in the models were equal to the endogenously determined pork and beef prices paid by consumers in the demand regions. These findings are consistent with equilibrium conditions for competitive markets because marginal cost is equal to price. The results are contingent on the assumption of fixed grain demands for exports, domestic processing, and residual uses. Results would be altered if these demands were permitted to adjust (as they tend to do over time).

Increasing the available acreage, removal of trade barriers, and harmonization of the direct income subsidies resulted in more specialization, increased shipments of grain and meat among regions, and more beef and grain shipments between the two countries. The level at which subsidies are harmonized has a significant effect on

Table 5. Change in Producer Surplus for Freer Trade Scenarios Relative to Base Model

	Model Solutions						
		FTA	Comprehensive FTA Scenarios			Sequential (Phase-in) FTA	
Region	Base	1989 Provisions	Upper Bound Subsidy[1]	Medium Subsidy Level[2]	Lower Bound Subsidy[3]	1987 Subsidy Level[4]	Medium Subsidy Level[2]
			——— ($/Acre) ———				
U. S.							
North Central U.S.	0	−2.20	−772.01	−761.43	−760.21	−372.03	−388.23
Southeast U.S.	0	6.88	−502.90	−508.51	−508.51	−242.11	−274.41
Plains U.S.	0	5.83	−429.51	−429.51	−429.51	−212.37	−244.92
Local U.S. Wheat	0	−8.47	−624.75	−606.55	−587.52	−300.16	−329.92
Weighted Avg. U.S.	0	1.41	−608.74	−601.78	−603.50	−295.14	−320.00
CANADA							
East Canada	0	8.29	−613.68	−610.09	−608.53	−161.51	−227.73
West Canada	0	9.44	−202.93	−204.12	−204.12	−34.60	−42.75
Weighted Avg. Canada	0	9.33	−242.44	−243.02	−243.60	−46.81	−60.54

[1]The upper bound subsidy represents a harmonization plan in which both countries equate their subsidies for respective commodities at the maximum rate paid to producers by either country in 1987.
[2]The medium subsidy level represents a harmonization plan in which both countries equate their producer subsidies for respective commodities at the minimum rate paid to producers by either country in 1987.
[3]The lower bound subsidy represents a harmonization plan in which both countries equate their subsidy rates for all commodities at zero dollars.
[4]Producer subsidies for the respective commodities and countries are not changed from the 1987 levels (harmonization does not occur).

both production and shipment patterns for both countries and the respective regions. Because the U.S. North Central region has a comparative advantage in the production of grain, the model increased grain production in the North Central region relative to the base period as direct income subsidies paid to producers decreased (Table 3). The medium subsidy level and the assumed lower bound subsidy models used all available acres in the North Central region to produce grain. In contrast, the U.S. Southeast and Plains and eastern and western Canada were at a comparative disadvantage when the direct income subsidies were reduced. For most grain, production either declined or remained unchanged in the models relative to the base period for these regions. The exceptions were increased corn production in the Southeast for the upper bound subsidy, increased wheat production in the Southeast for the medium subsidy level, and increased barley production in eastern Canada for both the medium subsidy and lower bound subsidy cases. These changes occurred because the favorable subsidy rates for these grains improved the measure of consumer surplus, the variable being maximized in the model.

When the assumed upper bound subsidies were paid to producers, total grain production increased relative to the base period for the Southeast, Plains, and eastern and western Canada (Table 3). The Southeast U.S. and eastern Canada regions increased corn output and decreased soybean production. Both the Plains and western Canada regions increased wheat and barley output. These four regions used all the available acreage in this scenario and therefore did not have land in the slack activities.

Because of the changing cost of grain as a feed, livestock production activities were also reallocated among the production regions of both the United States and Canada (Tables 1 and 2). For the assumed upper bound subsidy scenario, western Canada became more specialized in hog production, and eastern Canada became more specialized in beef production relative to the findings for the base model. Western Canada processed pork to meet its own demand and to make shipments into the western United States, while eastern Canada processed beef to meet its own demand and to ship beef into the northeastern United States. For Canada as a whole, both beef and pork production increased by 210 percent and 143.4 percent, respectively, relative to the results for the base model.

Based on the modeled results, the increased beef production in Canada more than offset the decrease in U.S. production of beef in the North Central region. The North Central region produced both less beef and pork relative to the base model because the relatively high Canadian soybean subsidy ($49.59 versus $0.41 for the United States) was included in the model as part of the assumed upper bound subsidy harmonization plan. Since the model produced more soybeans and less corn relative to the base period for this region, less corn was available to the North Central livestock industry.

In contrast to the North Central region, the Southeast increased its production of hogs, shipping relatively large quantities of processed pork into the South and Northeast (Table 2). Hog production increased in the Southeast in response to the decline in feeding costs reflecting the lower price of corn and reduced grain transportation costs.

The Plains also increased its production of cattle. Again, feed costs declined reflecting lower prices for barley. In total, the United States increased both hog and beef production by small percentages.

For the assumed upper bound subsidy scenario, the pounds of beef traded between the two nations increased, but both countries were self-sufficient in pork production. Canadian beef producers and processors gained relative to the U.S. beef sector. In total, the volume of pork traded between the two nations declined relative to the base model (Table 2).

In these solutions, the direct income subsidies paid to producers play a very important role in determining production levels and shipping patterns. When the assumed medium subsidy level and lower bound subsidy models were solved, production of all grains increased in the U.S. North Central region, while production of most grains decreased in the other regions. Because of the feeding advantage, hog production increased in the North Central region, was discontinued in the Southeast, decreased in eastern Canada, and increased slightly in western Canada relative to the base model (Table 1). Similar trends were also observed for beef production (Table 2). By examining shadow prices and using parametric programming techniques, it was determined that the Southeast region of the United States would produce hogs if the assumed medium subsidy rates for corn increased by $6.00 per acre.

Consumer and Producer Surplus Changes

The aggregate consumer surplus of the United States and Canada generated by the three models increased relative to the level for the base model (Table 4);

the increase in U.S. consumer surplus ranged from $15.8 billion for the assumed lower bound subsidy model to $19.5 billion for the assumed upper bound subsidy scenario. The increase in consumer surplus in Canada ranged from $1.6 billion to nearly $2.0 billion. These benefits were possible because consumer prices decreased as subsidies paid to producers increased. Thus, consumption of pork and beef increased.

In contrast to the increases in consumer surplus, the levels of producer surplus were reduced in all regions for all three models relative to the base solution (Table 5). The declines in producer surplus are closely associated with the existence of land in slack activities for these model scenarios as explained previously. A fundamental property of mathematical programming models is that the marginal value of additional units of a fixed resource not fully employed in solutions, i.e., used in slack activities, is zero. Thus, producer surplus declines under these scenarios are a direct result of the reduced marginal values of land when more land is assumed available for crop production as subsidies are harmonized.

Sequential FTA Policy: Phasing in FTA Provisions Through Time

In contrast to the comprehensive FTA policy, the free-trade provisions may be phased in throughout a 10-year or longer period. To evaluate the effects of a sequential FTA policy and the potential for additional dislocations or second-best solutions within the livestock and grain sectors, the trade restrictions were removed in succession within the models. First and simultaneously, Canadian import license requirements for U.S. wheat and barley exports and the U.S. Section 22 quota threats on Canadian grain were removed; second, the U.S. countervailing duties (CVD) on imports of Canadian hogs and pork and the Canadian countervailing duty on imports of U.S. corn were eliminated; third, the rail transportation subsidies for western Canadian grain shipments were abolished; and fourth, the direct income subsidies were harmonized. The ordering of the preceding liberalizations is based on the assumption that the CVDs are likely to be withdrawn prior to the elimination of the transport subsidies on western Canadian grain shipments.

Only minor differences existed in the successive modeled solutions upon removal of the first restrictions (elimination of import licenses and quota threats).[5] Therefore, the results for the elimination of the first three trade restrictions are combined and reported under the heading, Sequential (Phase-in) FTA, 1987 Subsidy Level (Tables 1-5). The fourth sequential change, harmonization of direct income subsidy levels for producers, is reported under the subheading, Medium Subsidy Level.[6]

Sequential FTA Model Results

Removal of Canadian import licenses, U.S. quota threats, and CVDs increased specialization and trade for both grain and livestock products relative to the base model (Tables 1, 2, and 3). Eliminating these trade barriers caused eastern Canada to shift about four million acres from corn to soybeans, while the North Central region made an offsetting acreage reversal from soybeans to corn production. The Plains region decreased barley production and increased wheat production. Corn acreage was substituted for wheat acreage in the southeastern United States.

Expanded corn output in the North Central and Southeastern regions lowered feed costs. Thus, both pork and fed cattle production increased in the United States, and all Canadian livestock production was eliminated. Moreover, pork and beef transport costs to consumer demand regions were minimized when the North Central U.S. region shipped both pork and beef to meet demands in both Canadian regions. Finally, harmonizing the direct income subsidies paid to producers did not appreciably change the solution (Tables 1, 2, and 3).

Relative to the Comprehensive FTA policy, phasing in provisions of the FTA over time introduced more dislocations for the Canadian fed beef and hog industries. That is, eliminating the Canadian licenses, U.S. quota threats, CVDs, and harmonization of direct income subsidies without compensatory acreage adjustments precluded hog and fed beef production in Canada and may have resulted in second-best solutions. The implications of these results are significant. Such a sequential approach may appropriately cause many Canadian producers and processors to oppose the introduction of additional provisions of the FTA.

Consumer and Producer Surplus Changes

The deletion of duties, quota threats, and CVDs on grain increased total consumer surplus by $9.9 billion relative to the base model (Table 4). Canada gained $858 million and the United States $9.1 billion. At best, this is about one-half the consumer surplus gain that was generated separately from one of three comprehensive FTA models. The harmonization of the

direct income subsidies to producers reduced consumer surplus relative to the results for the duties, quotas, and CVD model. This occurred because income subsidies to farmers were decreased slightly resulting in a higher cost of production and higher prices for meats.

For the same reasons, producer welfare levels were reduced in all regions for both models relative to the base solution (Table 5). However, the decrease in producer surpluses for the United States is about half the observed loss relative to those generated for producers for the comprehensive scenarios. The decrease in producer surpluses for Canada is about one-fourth that generated for the comprehensive scenarios.

Conclusions

The results suggest that the removal of tariffs and transport subsidies as specified in the initial phases of FTA implementation will not significantly affect the production, transportation, or use of grains and oilseeds in either country or for most regions. For livestock, the two-cent reduction in U.S. tariffs for beef imports did cause some adjustments in the initial FTA model. Consistent with theoretical reasoning, specialization occurred as the North Central United States and eastern Canada made offsetting adjustments in pork and beef output. The results indicate that beef production in eastern Canada could easily compete with North Central U.S. beef in the Northeast U.S. market with little added economic incentive. Production of hogs and grains in the southeastern United States is not affected by the initial 1989 free-trade provisions.

The findings further demonstrate that the initial FTA provisions will have minimal bearing on overall levels of producer and consumer surplus in the two nations. Regional levels of consumer surplus may be unevenly altered because of irregular pressures on the retail prices for pork and beef. Also, organized resistance to the initial provisions of the FTA from producer groups in either nation is unlikely given the relatively insignificant impacts noted in the FTA model results.

Comparisons of the model results for a comprehensive FTA policy versus a sequential FTA policy phased in through time provide insight into the difficulty encountered by a piecemeal approach to trade liberalization. These results illustrate that the Canadian livestock sector is displaced by simply opening the grain trade across the border. However, this outcome is reversed, and the livestock industries in Canada return to their pre-liberalization levels of activity when direct income subsidies paid to farmers are harmonized and acreage adjustments are made. This indicates that stability in the grain and livestock industries may be preserved by approaching totally free trade in one step relative to the dislocation caused by an incremental approach to the same end.

Taking such a step will require a careful analysis of the effect of harmonizing direct income subsidy payments to farmers. Some regions in the United States may find it difficult to competitively produce feed grains and hogs if and when subsidies are phased out.

The results further indicate that specialization occurs both within countries and among regions when the FTA is fully implemented. Further, consumer welfare, as measured in this model, increases for both nations and for all regions. In contrast, producer welfare, as measured in this model, declines for both nations and all regions. The significant changes in the regional concentrations of livestock production suggest that potentially displaced groups of Canadian beef and hog producers could actively oppose the full implementation of the free-trade agreement.

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APPENDIX

Tables 1 — 10

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Appendix Table 1. Production and Processing Costs and Feed Requirements for Livestock in the United States - Canada Model[1]

	HOGS	CATTLE
	---($US per head)---	
Production costs[2]	78	600
Processing costs[3]	36	163
Feed grains required:[4]	-----(bu/head)----	
Corn-only ration	13.3	51.6
Barley-only ration	n/a	66.7
Barley/wheat ration	12.6/4.5	n/a

[1]The methods and underlying techniques for these assumptions are in Worley, C.T: pp. 64-73.
[2]Includes all fixed and variable costs except expenses for the endogenously determined feed grains.
[3]Assumed same technology and processing costs in all regions.
[4]Requirements to finish hogs from 40# to 240# and beef from 600# to 1200#.

Appendix Table 2. Distance Between Livestock Production Regions and Processing Regions Used to Calculate Livestock Transportation Cost[1]

	PROCESSING REGIONS					
Production Region and Base City	NC U.S.	SE U.S.	East Can.	West Can.	U.S. Plains	West U.S
			----Miles----			
N.C. United States Des Moines	150[3]	1137	847	1710	397	1759
S.E. United States Raleigh	1137	150[3]	813	2837	—	—
East Canada Toronto	847	813	150[3]	2275	1242	3046
West Canada Edmonton	1710	2837	2275	150[3]	1844	1683
Plains, United States Wichita	397	–[4]	1242	1844	150[3]	1536
West, United States Fresno	1759	–[4]	3046	1683	1536	150[3]

[1]Transportation costs/head=[(specified mileage)x$1.22/mi]÷183 hogs or 40 cattle.
[2]Since hog production in the U.S. Plains and U.S. West regions was excluded from the model, hog shipments from the S.E. to the U.S. Plains and U.S. West were omitted.
[3]Assumed a distance of 150 miles for intra-region shipments from farms to processor.
[5]Since beef processing in the S.E. was excluded in the model, beef shipments from U.S. Plains and U.S. West to the S.E. were omitted.

Source: Rand McNally Atlas.

Appendix Table 3. Base Cities and Mileages Between Meat Processing Regions and Demand Regions Used to Calculate Transportation Costs for Meat

Processing Regions:	Demand Regions:
NCENT—Des Moines	West—Sacramento
SEAST—Raleigh	Midwest—Chicago
PLNS—Wichita	South—Montgomery, AL
ECAN—Toronto	NEAST—New York
WCAN—Edmonton	ECAN—Ottawa
	WCAN—Calgary

	DEMAND REGION					
Processing Region	NC U.S.	Mid-West	South U.S.	West U.S.	East Can.	West Can.
			— — — — Miles — — — —			
N.C. United States	1149	329	921	1765	1114	1540
S.E. United States	500	848	545	2857	819	2677
Plains, United States	1472	724	885	1603	1490	1678
East Canada	502	518	1073	2612	248	2115
West Canada	2777	1805	2723	1525	2523	160

Costs are based upon $1.22 per mile for 44,000 lb. shipments.

Source: Rand McNally Road Atlas

Appendix Table 4. Pork and Beef Demand Coefficients for Six United States and Canadian Regions

Regions[1]	Q_r	Intercept	Slope
	— — — — — — — PORK — — — — — — —		
Northeast, U.S.	2,947,000,000	4.465	8.758E-10
South, U.S.	4,943,000,000	4.465	5.222E-10
Midwest, U.S.	3,488,000,000	4.465	7,400E-10
West, U.S.	2,936,000,000	4.465	8.791E-10
Eastern Canada	1,134,500,000	4.752	2.421E-9
Western Canada	458,000,000	4.752	5.997E-9
	— — — — — — — BEEF — — — — — — —		
Northeast, U.S.	4,859,000,000	6.156	7,678E-10
South, U.S.	8,148,000,000	6.156	4.579E-10
Midwest, U.S.	5,751,000,000	6.156	6.487E-10
West, U.S.	4,840,000,000	6.156	7.708E-10
Eastern Canada	1,550,000,000	6.549	2.561E-9
Western Canda	625,000,000	6.549	6.351E-9

[1]See Figure 4 to identify U.S. demand regions.

Appendix Table 5: United States and Canadian Average Grain Yields and Cropland Acreage for Six Crop Production Regions, 1987

GRAIN	PRODUCTION REGIONS					
	North Central U.S.	South East U.S.	Plains U.S.	Eastern Canada	Western Canada	Wheat U.S.
	— — — — Bushels Per Acre — — — —					
Corn	126	82	117	112	—	—
Barley	—	—	—	56	51	—
Soybeans	39	22	33	41	—	—
Canola	—	—	—	—	26	—
Wheat	49	39	33	—	28	48
	— — — — 000 Acres — — — —					
Crop acres available	80427	22764	60599	5375	50496	10540

Source: Derived from USDA statistics for acreage and production.

Appendix Table 6: Variable Grain Production Costs by Region in the United States - Canada Model

GRAIN	North Central U.S.	South East U.S.	Plains U.S.	Eastern Canada	Western Canada	Other Wheat
	— — — — $ Per Acre — — — —					
Corn	141	141	141	126	—	—
Barley	—	—	47	69	47	—
Soybeans	87	87	87	82	—	—
Canola	—	—	—	—	47	—
Wheat	68	68	49	—	50	56

Source: Worley, C.T.

Appendix Table 7. Estimated Distances in Miles for Shipping Grain from Production Regions to Exogenous Demand Regions Used to Calculate Grain Transportation Costs

	EXPORTS					
Region	Vancouver	St. Lawrence	Lakes	Gulf	East Coast	West Coast
NCENT	2,113	1,223	563	977	1,194	1,800
SEAST	3,252	890	563	872	178	2,937
PLNS	2,100	2,626	920	864	1,411	1,784
ECAN	1,767	303	303	1,377	704	2,574
WCAN	812	2,651	2,039	2,706	2,847	1,067
USWHT	812	2,651	2,039	2,706	2,847	1,067
WSWHT						500

	PROCESSING						
	East Canada	West Canada	North Central	South East	Plains	North East	West
NCENT	847	1,550	100	1,137	397	754	1,800
SEAST	813	2,687	1,137	100	1,037	713	2,937
PLNS	1,323	1,682	397	1,037	100	1,223	1,784
ECAN	100	2,115	847	813	1,323	100	2,574
WCAN	2,275	100	1,710	2,847	1,842	2,342	1,067
USWHT						300	500

	LIVESTOCK OTHER THAN PORK AND BEEF	
	U.S.	Canada
NCENT	100	1,000
SEAST	100	1,000
PLNS	100	1,000
ECAN	1,000	100
WCAN	1,000	100
USWHT	100	1,000

Source: Rand McNally Atlas where applicable to base cities

Appendix Table 8. Exogenous Grain Demand by Grain Demand Type and Demand Region

	EXPORT					
Region	Vancouver	St. Lawrence	Lakes	Gulf	East Coast	West Coast
			(000,000 Bu.)			
Corn	—	—	79	995	221	184
Soybeans	—	—	48	627	79	40
Wheat	431	382	83	553	52	355
Barley	138	112	—	—	—	—
Canola	90	—	—	—	—	—

	PROCESSING						
	East Canada	West Canada	North Central	South East	Plains	North East	West
				(000,000 Bu)			
Corn	47	—	1,187	—	—	—	—
Soybeans	47	—	659	400	117	—	—
Wheat	37	16	317	138	195	570	106
Barley	—	16	—	—	—	—	—
Canola	—	79	—	—	—	—	—

	LIVESTOCK OTHER THAN PORK AND BEEF	
	U.S.	Canada
	(000,000 Bu.)	
Corn	1,119	87
Soybeans	96	1
Wheat	208	116
Barley	—	56
Canola	—	—

Source: Derived from USDA Situation Reports and Agriculture Canada statistics.

Appendix Table 9. Direct Income Subsidies for the United States and Canada

	Direct Income Subsidies/Acre in US $	
	U.S.	Canada
Corn	$125.68	$63.37
Barley	33.31	14.95
Soybeans	0.41	49.59
Canola	—	37.98
Wheat	60.54	26.64

Source: Webb, A.J., M. Lopez and R. Penn

Appendix Table 10. United States and Canadian Tariff Rates and Countervailing Duties for Specified Commodities

Commodity	U.S. Tariff Rates	U.S. Countervailing Duties
	(US$Unit)	
Wheat	$.21/bu.	—
Barley	.05/bu.	—
Corn	.05/bu.	—
Canola	.20/bu.	—
Soybeans	-0-	—
Live Cattle	.01/lb.	—
Live Hogs	-0-	$.039/lb.
Beef	.02	—
Pork	-0-	—

Commodity	Canadian Tariff Rates	Canadian Countervailing Duties
	(US$/Unit)	
Wheat	.09/Bu.	—
Barley	.038/Bu.	—
Corn	-0-	$0.64/Bu.
Soybeans	-0-	—
Canola	-0-	—
Live Cattle	.0038/lb.	—
Live Hogs	-0-	—
Beef	.015/lb.	—
Pork	-0-	—

Source: Normile, USDA

End Notes

1. U.S. countervailing duty actions on imports of Canadian hogs and pork and Canadian countervailing duties on imports of U.S. corn were in place prior to negotiation of the FTA. Chapter 19 of the FTA permitted these countervailing duties to continue in effect.
2. The quadratic model is applicable for sector analysis because the optimal value of its objective function measures maximum producer and consumer surplus at equilibrium prices and quantities (Samuelson 1952) and (Takayama and Judge 1964). This equilibrium condition is imposed on empirical programming model solutions that incorporate the welfare attributes of the real theoretical trade models (McCarl and Spreen 1980, pg. 4).
3. Since yields are not decreased as the additional acreage is added, the results may overstate the number of acres that are in the slack activities, the decrease in producer surplus, and the increase in consumer surplus. However, the margin of error should be small because as reported elsewhere, "The range of outcomes for various slippage specifications is not very wide" (Haley, Herlihy and Johnston).
4. Other minor grains or grasses or legumes may be grown on this land. In the Southeast it is conceivable that sugarcane, cotton, or rice acreage could also shift into grain or soybean production. Since these commodities were not included in the model, these potential transfers cannot occur. Thus, the amount of fallow land may be overstated, and producer surplus may be understated.
5. When prior runs were made without the introduction of the direct income PSEs, different optimum solutions appeared as the trade restrictions were relaxed.
6. The assumed upper bound subsidy level model was run but its results are not reported here, as its basic solution provided intermediate levels of output relative to the two prior solutions.

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