Journal of Agricultural and Applied Economics, 30,2(December 1998):277–284

A Sectoral Analysis of Agricultural Trade Liberalization

P. Lynn Kennedy and Cemal Atici

ABSTRACT

Complete agricultural trade liberalization between the United States and the European Union is examined with respect to the agricultural sector. A static, partial equilibrium model, distinguishing among the European Union, the United States, and a politically passive rest of the world, is used to simulate agricultural free trade. The results of this research reveal how European Union and United States adoption of free trade affects domestic and world prices, production, consumption, self-sufficiency, and welfare.

Key Words: agricultural policy, European Union, trade liberalization, United States.

The need to focus on reducing agricultural protection levels has become increasingly apparent to the agricultural policy community in recent years. For example, it has been argued that a large amount of the agricultural price support benefits in developed countries go to a shrinking percentage of the economy (Cochrane). In addition, budget pressures felt by many developed countries contribute to the call for agricultural policy reform (von Witzke and Hausner). Domestic pressures of this type contributed to the negotiation and completion of the Uruguay Round of the General Agreement on Tariffs and Trade (GATT). They also have added to the formation and modification of various regional trading blocks.

The United States and the European Union (EU) were major participants in the talks leading up to the final Agricultural Agreement in the Uruguay Round of GATT. Following this, the possibility has been suggested of a Trans-Atlantic Free Trade Area that would include these two major players in the world agricultural market (Frankena). Given the turbulent history involving the agricultural policy of these regions, cooperation of this type could result in efficiency gains that benefit both the U.S. and EU, as well as the rest of the world.

Changes in agricultural protection brought about through multilateral and regional trade agreements will affect various interest groups. Recent literature has addressed the issue of agricultural policy changes related to GATT (Johnson, Mahé, and Roe) and the North American Free Trade Agreement (NAFTA) (Robinson, Burfisher, and Hinojosa-Ojeda) with respect to agricultural producers, consumers, and taxpayers. Analyses of this variety typically indicate that the removal of trade barriers by an importing country will increase the welfare of consumers, decrease the welfare of producers, and decrease net government revenue. It follows that domestic production will decrease, while domestic consumption and imports will increase as a result of a lower domestic price. Although work has been conducted that examines the effects of various

The authors are assistant professor and graduate assistant, respectively, in the Department of Agricultural Economics and Agribusiness, Louisiana State University Agriculture Center, Baton Rouge.

This article has been approved for publication by the Louisiana Agricultural Experiment Station as publication number 97-05-0373.

trade agreements, such as GATT and NAFTA (Barichello et al.; Grennes et al.; Josling et al.), little has been done to examine the impact of the United States and the European Union adopting free trade.

The purpose of this study is to examine the impact of EU-U.S. agricultural protection elimination for producers, consumers, and the government budget sector. The benefits of this exercise are twofold. First, measuring the welfare gains/losses resulting from trade liberalization provides policy makers and interest groups with information as to the outcome of the potential policy scenario. Conversely, the welfare lost as the result of the new policy provides a measure of the rents occurring as a result of current policies. To accomplish this, a world trade model is used to analyze the effects of agricultural trade liberalization by the European Union and the United States. These results then are utilized to determine the impacts in each of the sectors with respect to changes in domestic and world prices, production, consumption, and welfare.

To accomplish these objectives, the article proceeds in the following manner. First, an overview is provided of the economic and empirical model used in the analysis. Next, the data used in the specification of the model are reviewed, and the results of the analysis are presented. In the concluding section, several implications from this research are discussed.

Overview of the Model

This analysis employs a multi-commodity model of agriculture. In the model, N commodities are produced, consumed, and traded by K main countries and the rest of the world. Vectors of supply, demand, and excess demand represent the levels of aggregate production, consumption, and trade for each country. The supply sector in country k ($k = 1, \ldots, K$) produces a combination of the N commodities in order to maximize profits, given prices, technology, and endowments.

Modèle Internationale Simplifié de Simulation (MISS) is used to simulate the effects of agricultural trade liberalization by the European Union and the United States. MISS is a simplified world trade model that utilizes a comparative static framework to model the effects of various policy actions (Mahé, Tavèra, and Trochet). The model uses several identities to simulate policy changes in the sectors of supply, derived demand, and final demand for the regions examined. The model operates on the principle of Walrasian equilibrium. Policy changes undertaken by a country cause adjustments in the world price levels, resulting in changes in supply and demand and a rebalancing of world trade.

Initial world market equilibrium for commodity i ($i = 1, \ldots, N$) occurs where supply is equal to the summation of derived demand, final demand, and the change in stocks. This initial equilibrium is represented by the following equation:

$$\sum_k S_{ik} = \sum_k D_{ik} + \sum_k Q_{ik} + \sum_k ST_{ik}$$
$$\forall\ i = 1, \ldots, N,$$

where S_{ik}, D_{ik}, Q_{ik}, and ST_{ik} represent supply, derived demand, final demand, and change in stocks (final stocks minus initial stocks), respectively, for commodity i in country k.

To analyze the impact of agricultural protection, the model links price and nonprice policy variables with quantities. Percentage changes in the supply and derived demand of commodity i are composed of supply price and derived demand price effects and shifts resulting from nonprice variables. These percentage changes are represented by the equations:

$$s_{ik} = \sum_j (E^*_{ijk} \times p^S_{jk} + E^{**}_{ijk} \times p^D_{jk}) + r^S_{jk},$$

and

$$d_{ik} = \sum_j (F^*_{ijk} \times p^S_{jk} + F^{**}_{ijk} \times p^D_{jk}) + r^D_{jk},$$
$$\forall\ i, j = 1, \ldots, N, \quad \text{and}$$
$$k = 1, \ldots, K,$$

where s_{ik} and d_{ik} represent percentage changes in supply and derived demand for commodity i in country k, E^*_{ijk} and E^{**}_{ijk} represent the ma-

trices of supply elasticities, and F^{*}_{ijk} and F^{**}_{ijk} represent the matrices of derived demand elasticites for commodity i with respect to output and input prices of commodity j. Percentage changes in domestic supply and derived demand prices for commodity j in country k are shown as p^{S}_{jk} and p^{D}_{jk}, respectively. In addition, r^{S}_{jk} and r^{D}_{jk} are quantity shifters for supply and derived demand, respectively.

The percentage change in the final demand of commodity i is composed of final demand price effects with respect to price changes for all commodities and shifts resulting from nonprice variables. These percentage changes are represented by:

$$q_{ik} = \sum_{j} G_{ijk} \times p^{Q}_{jk} + r^{Q}_{jk} \qquad \forall\, i, j = 1, \ldots, N, \quad \text{and} \quad k = 1, \ldots, K,$$

where q_{ik} represents percentage change in demand for commodity i in country k. G_{ijk} represents the matrix of demand elasticities for commodity i with respect to consumer prices of commodity j. Percentage changes in consumer prices for commodity j in country k are denoted by p^{Q}_{jk}. In addition, r^{Q}_{jk} is a quantity shifter for final demand.

The domestic/world price linkage is such that the domestic price is a function of the world price, the exchange rate, domestic protection, and transportation costs. This is represented by:

$$P^{N}_{ik} = P^{W}_{i} \times C_{k} \times T^{N}_{ik} \times W_{k}$$

or, in logarithmic terms, where W_k is fixed,

$$p^{N}_{ik} = p^{W}_{i} + c_{k} + t^{N}_{ik} \qquad \text{for } N = (S, D, Q),$$

where P^{N}_{ik} represents the domestic prices of commodity i in country k, P^{W}_{i} represents the world price for commodity i, C_k represents the number of country k currency units per one European Currency Unit, T^{N}_{ik} represents the protection coefficient for commodity i (the ratio of domestic price to border price), and W_k denotes a margin coefficient representing transportation costs. Lowercase letters denote a percentage change in the respective variables.

Final world market equilibrium for commodity i occurs where the change in supply for each commodity is equivalent to the corresponding sum of changes in derived and final demand. Combining the previous equations, this is specified as:

$$(1) \qquad \sum_{k} S_{ik} \times s_{ik} = \sum_{k} D_{ik} \times d_{ik} + \sum_{k} Q_{ik} \times q_{ik} \qquad \forall\, i = 1, \ldots, N.$$

As a result of policy changes undertaken by either country, adjustments occur in supply, derived demand, and final demand, such that equation (1) is satisfied for each commodity. Products of the policy simulation used to reach this final world market equilibrium reveal how the adoption of free trade affects domestic and world prices, production, consumption, self-sufficiency, and welfare.

Data and Model Specification

For the purposes of this examination, the world is divided into three regions: the European Union (EU), the United States (U.S.), and the rest of the world (ROW). This analysis is conducted using seven commodity groups of importance to the EU and U.S. They are wheat and coarse grains, oilmeals, feed grain substitutes [(FGS)—including millings and other vegetable by-products, corn gluten feed, maniac, and citrus pulp], beef, pork and poultry, milk and dairy products, and sugar.

The data used to initialize the model are composed of production, derived demand, and final demand for each of the three regions. European Union and United States protection levels, world prices, and elasticities were obtained for each commodity group. This information for the 1990 base year was obtained for each of the seven commodity groupings from *The Agricultural Situation in the Community* (Statistical Office of the European Communities); *Production Yearbook* and *Trade Yearbook* [United Nations/Food and Agriculture Organization (UN/FAO)]; and *Agricultural Statistics, Agricultural Outlook,* and

Table 1. Summary of 1990 Protection Coefficients for the EU and the U.S.

	European Union			United States		
Commodity	Production	Intermed. Demand	Final Demand	Production	Intermed. Demand	Final Demand
Cereals	1.78	1.80	1.80	1.60	1.10	1.10
Oilmeals	2.30	1.00	1.00	1.00	1.00	1.00
FGS	1.00	1.00	1.00	1.00	1.00	1.00
Beef	1.65	1.65	1.65	1.05	1.05	1.05
Pork & Poultry	1.25	1.25	1.25	1.00	1.00	1.00
Dairy	1.90	0.90	1.80	1.95	1.95	1.74
Sugar	2.70	2.70	2.70	2.30	2.30	2.30

Sources: The Agricultural Situation in the Community (Statistical Office of the European Communities); *Agricultural Statistics, Agricultural Outlook,* and *World Agricultural Supply and Demand Estimates* (USDA); and *Production Yearbook* and *Trade Yearbook* (UN/FAO).
Note: Protection coefficients are the ratio of domestic prices to border prices.

World Agricultural Supply and Demand Estimates [U.S. Department of Agriculture (USDA)]. The protection coefficients for the 1990 base year are shown in table 1.

To model the interrelationship between the United States and the European Union, the actual rates of protection and policy instruments for the base period must be represented as accurately as possible. The agricultural pricing policy for the United States is summarized as follows. Cereals are supported by means of a target price combined with a set-aside program and the Export Enhancement Program. Oilmeal production is supported by the Commodity Credit Corporation loan rate for oilseed producers. The price of beef is supported through an import tariff. No support program exists for pork and poultry. The producer price for milk is supported at a level slightly higher than the supported consumer price. Finally, a fixed domestic price for sugar is obtained by means of an import quota.

In the European Union, a co-responsibility levy results in the producer price of cereals being slightly lower than the consumer cereal price, which is fixed by a variable levy. A GATT agreement binds EU tariffs for oilmeal and feed grain substitutes at zero; thus consumer prices are equal to world prices. The EU also subsidizes the production of oilmeals. Beef, pork and poultry, dairy, and sugar are supported through the variable levy system. Dairy is also protected by means of a production quota.

Empirical Results

The removal of agricultural trade barriers is simulated in the MISS model using the actual policy tools and protection levels described in the previous section. The base period price guarantees, subsidies, tariffs, and quotas are eliminated to simulate free trade. Protection coefficients presented in table 1 are reduced to 1.00.

Free trade affects world prices in various ways, depending on the commodity analyzed. As reported in table 2, projected world price increases are approximately 8–9% for beef and cereals, respectively, 27% for dairy, and 22% for sugar. At the same time, oilmeal, feed grain substitutes, and pork and poultry prices decrease by approximately 10%, 31%, and 2%, respectively. These changes in world prices are due to shifts in production and consumption on the part of the U.S. and EU. Several commodities, such as oilmeals and feed grain substitutes, undergo a decrease in world prices. This is partially attributed to the shift in relative commodity prices, resulting in increased cereal consumption. A comparison of the free trade world price and the actual producer price levels is also presented in table 2. With the exception of the U.S. beef sector, the

Table 2. 1990 EU, U.S., and World Prices, and Projected World Free Trade Prices (U.S. $/ton)

	1990 Price			Free Trade Price	
Commodity	EU	U.S.	World	World	% Change
Cereals	203.45	173.74	114.30	124.71	9.11
Oilmeals	455.68	188.21	198.12	178.84	−9.73
FGS	152.40	152.40	152.40	105.89	−30.52
Beef	4,337.69	2,760.35	2,628.90	2,840.94	8.07
Pork & Poultry	1,905.00	1,524.00	1,524.00	1,496.92	−1.78
Dairy	282.32	304.24	148.59	189.27	27.38
Sugar	702.95	598.81	260.35	317.31	21.88

Sources: The Agricultural Situation in the Community (Statistical Office of the European Communities); *Agricultural Statistics, Agricultural Outlook,* and *World Agricultural Supply and Demand Estimates* (USDA); *Production Yearbook* and *Trade Yearbook* (UN/FAO); and computed.

free trade world price is lower than the corresponding EU or U.S. protected price.

The changes in welfare resulting from free trade are presented in table 3. Implications of relative domestic and world prices are seen here. All producers experience a welfare loss, with the exception of U.S. beef producers. In addition, the consumer and government budget sectors in both countries are better off as a result of free trade.

As a result of the shift in world and domestic prices, domestic production, consumption, and self-sufficiency are influenced, as shown in tables 4, 5, and 6, respectively. Similar to the change in domestic prices, EU production of cereals, oilmeal, beef, dairy, and sugar decreases. Production of feed grain substitutes and pork and poultry increase. The only U.S. sectors to increase production are beef, oilmeals, and pork and poultry. Total EU demand increases for each of the commodities with the exception of oilmeals and feed grain substitutes. U.S. results show cereals and beef as the only two sectors with a decline in total demand.

Table 3. Changes in 1990 EU and U.S. Interest Group Welfare Resulting from Free Trade (U.S. $ mil.)

Sector	European Union	United States
Cereals	−11,858.75	−15,665.15
Oilmeals	−2,799.73	−898.79
FGS	−728.22	−554.85
Beef	−9,548.24	1,080.21
Pork & Poultry	−2,700.77	−94.03
Dairy	−6,413.46	−5,776.58
Sugar	−5,277.23	−1,497.10
Production	−39,326.40	−23,406.29
Consumption	38,005.84	7,014.92
Gov't. Budget	13,354.58	20,151.65
Total	12,034.02	3,760.28

Source: Computed.

Changes in production and consumption are combined to form the change in self-sufficiency (table 6). It is important to note that the measure of self-sufficiency used in this analysis is the ratio of domestic production to domestic consumption. United States self-sufficiency decreases with the exception of beef, oilmeals, and pork and poultry. A similar decline in self-sufficiency is seen for the European Union, with the exception that feed grain substitutes and pork and poultry rates increase.

These results, derived from the empirical analysis, can be compared to those expected from theory. First, theory predicts that the removal of a tariff will decrease raw commodity production and producer welfare provided the protection price is greater than the world price. As shown earlier, the scenarios simulated in the MISS model are consistent with these predictions. Production levels decrease for commodities with relatively high protection levels as a result of trade liberalization. Commodity sectors increasing production had low initial levels of protection. Thus, their relative protection levels actually increased as compared to other sectors.

Table 4. Actual 1990 and Simulated Free Trade Production Quantities (mil. metric tons) and Corresponding Percent Changes for the EU and U.S.

	European Union			United States		
Commodity	Actual	Simulated	% Change	Actual	Simulated	% Change
Cereals	168.77	134.02	−20.59	305.21	258.33	−15.36
Oilmeals	13.10	7.13	−45.54	46.28	49.23	6.37
FGS	15.58	15.73	0.98	12.30	11.56	−6.03
Beef	8.02	6.22	−22.47	10.46	11.03	5.46
Pork & Poultry	19.25	20.95	8.85	17.81	18.51	3.93
Dairy	109.02	79.36	−27.21	67.38	48.74	−27.67
Sugar	17.01	10.29	−39.51	6.27	4.37	−30.32

Sources: The Agricultural Situation in the Community (Statistical Office of the European Communities); *Agricultural Statistics, Agricultural Outlook,* and *World Agricultural Supply and Demand Estimates* (USDA); and computed.

Changes in interest group welfare are also consistent with those hypothesized by theory. The majority of raw commodity production sectors suffered welfare losses as the result of free trade. The only production sector to experience a welfare gain was the U.S. beef sector. This result is partially due to the decline in the price of inputs used in the beef industry. Gains to consumers and the government budget sector create the situation where it may be possible to partially compensate producers for their losses.

Theory also suggests that the removal of agricultural commodity protection will decrease the rate of self-sufficiency. Again the results of the simulations are consistent with theory. Self-sufficiency declined as a result of the removal of protection levels in all instances, with the exceptions of the U.S. beef sector, U.S. pork and poultry, and EU feed grain substitutes and pork and poultry. Similar to the relationship between trade liberalization and production, the reduction in self-sufficiency was dependent on the relative level of protection removal with respect to other commodities.

Summary and Conclusions

Analyses of this type provide several implications regarding the impact of trade liberalization on agricultural producers, processors, and consumers. The results of this examination show that EU and U.S. adoption of free trade will result in a decrease in government budget expenditures and, for most commodities, a decrease in domestic production, producer prices and welfare, and self-sufficiency. Given these results, several implications can

Table 5. Actual 1990 and Simulated Free Trade Consumption Quantities (mil. metric tons) and Corresponding Percent Changes for the EU and U.S.

	European Union			United States		
Commodity	Actual	Simulated	% Change	Actual	Simulated	% Change
Cereals	142.76	162.92	14.12	215.97	205.04	−5.06
Oilmeals	33.31	25.33	−23.96	23.40	23.63	0.98
FGS	34.00	29.38	−13.59	7.88	8.57	8.76
Beef	7.58	9.53	25.73	10.82	10.41	−3.79
Pork & Poultry	18.73	19.54	4.32	17.42	17.71	1.66
Dairy	90.31	94.11	4.21	63.96	72.34	13.10
Sugar	12.81	16.59	29.51	7.96	9.33	17.21

Sources: The Agricultural Situation in the Community (Statistical Office of the European Communities); *Agricultural Statistics, Agricultural Outlook,* and *World Agricultural Supply and Demand Estimates* (USDA); and computed.

Table 6. Initial 1990 and Free Trade Rates of Self-Sufficiency for the EU and U.S.

	European Union		United States	
Commodity	Initial	Free Trade	Initial	Free Trade
Cereals	1.182	0.823	1.413	1.260
Oilmeals	0.393	0.282	1.978	2.083
FGS	0.458	0.536	1.561	1.349
Beef	1.058	0.652	0.967	1.060
Pork & Poultry	1.028	1.072	1.022	1.045
Dairy	1.207	0.843	1.053	0.674
Sugar	1.328	0.620	0.788	0.468

Sources: The Agricultural Situation in the Community (Statistical Office of the European Communities); *Agricultural Statistics, Agricultural Outlook,* and *World Agricultural Supply and Demand Estimates* (USDA); *Production Yearbook* and *Trade Yearbook* (UN/FAO); and computed.

Note: Self-sufficiency is the ratio of domestic production to domestic consumption.

be derived pertaining to future agricultural trade liberalization.

Based on the sectoral welfare gains and losses resulting from the adoption of free trade, policy makers must determine the political prudence of adopting such strategies. Clearly, if all interest groups have the same ability to garner political support, this analysis indicates that the overall welfare of both countries will improve as a result of removing protection levels. However, if some groups, such as agricultural producers, achieve disproportionately high favor in the sight of the policy makers, this free trade scenario may not be perceived as superior to the original state of protection.

Regardless of the relative political weights of the relevant interest groups, the results of this simulation can be utilized to achieve some degree of trade liberalization. Since trade liberalization results in government budget savings, certain producers suffering a welfare loss could be compensated through a lump-sum payment in order to achieve a politically superior solution. The findings of this analysis can aid policy makers in determining the types of policies that, combined with free trade, will result in politically feasible solutions.

Another issue relevant to agricultural protection discussions is self-sufficiency. Maintaining or achieving food self-sufficiency is often given as a reason for protecting agriculture. The results of this analysis can aid in achieving a desired level of self-sufficiency subject to policy-related budget expenditures. At the same time, as countries increase participation in regional trading blocks, decreased self-sufficiency for an individual country may correspond with increased self-sufficiency in a regional block to which the country belongs. Consequently, increased regional and international stability lessens the need for self-sufficiency in individual countries.

If government officials are to utilize the results of this study in formulating agricultural policies, they must be aware of the limitations of this research. First, the model is static in nature. It does not account for long-run increases in demand that will occur as the result of free trade. In addition, the free trade scenario simulated in this model does not account for long-run adjustments in production that correspond with free trade. As factors such as these shift the supply and demand curves, the effects of trade liberalization will be influenced.

So that policy makers may be better equipped to identify politically feasible policies that are World Trade Organization (WTO) legal, more sophisticated models that build on the research presented here must be developed. Challenges for future research include the incorporation of political economics within this type of framework. In addition, as the agricultural mini-round of the WTO is set to begin in 1999, and as regional trade agreements continue to proliferate, policy analysis of this nature will be beneficial in analyzing potential policy scenarios and the formation of various potential coalitions within and among countries.

References

Barichello, R., L. Bivings, C. Carter, T. Josling, P. Lindsey, and A. McCalla. "The Implications of a North American Free Trade Area for Agriculture." Commissioned Pap. No. 11, International

Agricultural Trade Research Consortium, St. Paul MN, 1991.

Cochrane, W.W. *The Development of American Agriculture: A Historical Analysis.* Minneapolis MN: University of Minnesota Press, 1979.

Frankena, K. "Trans-Atlantic Ties to Be Strengthened." *Internat. Econ. Rev.* 36(1995):8–10.

Grennes, T., J. Hernandez-Estrada, B. Krissoff, J. Matus-Gardea, J. Sharples, and C. Valdes. "An Analysis of a United States-Canada-Mexico Free Trade Agreement." Commissioned Pap. No. 10, International Agricultural Trade Research Consortium, St. Paul MN, 1991.

Johnson, M.A., L. Mahé, and T. L. Roe. "Trade Compromises Between the European Community and the U.S.: An Interest Group-Game Theory Approach." *J. Policy Modeling* 15(1993): 199–222.

Josling, T., M. Honma, J. Lee, D. MacLaren, B. Miner, D. Sumner, S. Tangermann, and A. Valdes. "The Uruguay Round Agreement on Agriculture: An Evaluation." Commissioned Pap. No. 9, International Agricultural Trade Research Consortium, St. Paul MN, 1994.

Mahé, L., C. Tavèra, and T. Trochet. "An Analysis of Interaction Between EC and U.S. Policies with a Simplified World Trade Model: MISS." Background paper for the Report to the Commission of the European Communities on Disharmonies in EC and U.S. Agricultural Policies, Brussels, Belgium, 1988.

Robinson, S., M.E. Burfisher, and R. Hinojosa-Ojeda. "Agricultural Policies and Migration in a U.S.-Mexico Free Trade Area: A Computable General Equilibrium Analysis." *J. Policy Modeling* 15(1993):673–701.

Statistical Office of the European Communities. *The Agricultural Situation in the Community.* Brussels, Belgium. Various issues, 1990–91.

United Nations, Food and Agriculture Organization. *Production Yearbook.* UN/FAO, Rome, Italy, 1990.

———. *Trade Yearbook.* UN/FAO, Rome, Italy, 1990.

U.S. Department of Agriculture, Economic Research Service and Foreign Agricultural Service. *World Agricultural Supply and Demand Estimates.* USDA/ERS/FAS, Washington DC. Various issues, 1990–91.

U.S. Department of Agriculture, Economics and Statistics Service. *Agricultural Outlook.* USDA/ESS, Washington DC. Various issues, 1990–91.

U.S. Department of Agriculture, National Agricultural Statistics Service. *Agricultural Statistics.* USDA/NASS, Washington DC. Various issues, 1990–91.

von Witzke, H., and U. Hausner. "The Political Economy of Agricultural and Trade Policy in Open Economies: Implications for International Cooperation in the GATT." Staff Pap. No. P91-14, Dept. of Agr. and Appl. Econ., University of Minnesota, April 1991.