Competitiveness of U.S. Agricultural Products in the World Market

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Agricultural trade in the mid-1970s showed an unprecedented growth. During this period, the United States increased its export market share in many agricultural commodities. Since 1981, however, export market shares for agricultural products have declined steadily.

Many factors contributed to the fall of agricultural trade in the 1980s. The Office of Technology Assessment (11) conducted a study which identified five major factors: 1) world economic recession, 2) an overvalued dollar, 3) increased government intervention, 4) greater self-sufficiency of developing countries, and 5) adoption of new farming technology in exporting countries. Factors 1), 2), and 3 are temporary economic phenomena based on economic policies of importing and exporting countries. A large body of literature has examined the impacts of these economics issues on agricultural trade. Factors 4) and 5) are production-related trade issues based on principles of comparative and competitive advantages. The studies analyzed competitiveness of U.S. agricultural products for production and marketing costs in the World Market [Ortmann et al.(12); Stanton (13); Koo and Thompson (9); Bawden(2)].

The issue of "competitiveness" recently has received special attention mainly because of the Uruguay round of Gatt negotiations. Unlike the previous GATT negotiations, the Uruguay round emphase free trade for agricultural products. The United States proposed eliminating all government programs which distort trade of agricultural products and receive partial support from member nations. The outcome of the GATT negotiations is unknown. However, trade for agricultural products probably will become much freer because of the GATT negotiations. This implies that trade flows of agricultural products and exporting countries' market shares will be determined more by international competitiveness of a product based on the principal of competitive advantage than by domestic programs and subsidies.

The main objective of this study is to evaluate competitiveness of agricultural products produced in the United States in the world market. Special attention is given to agricultural products produced in North Dakota and their competitiveness in the world market. This study includes the principal of comparative advantage by allowing trade among exporting countries in addition to trade between exporting and importing countries and also includes the principle of competitive advantage by allowing competition among exporting countries in each importing region.

SPATIAL EQUILIBRIUM MODEL

A spatial equilibrium model for world trade of wheat, corn, and soybeans is developed on the basis of a mathematical programming algorithm. In this model, wheat is divided into three categories: winter wheat, spring wheat, and soft wheat.

The model determines optimal production of the crops in each producing region of exporting countries and optimal distribution of these crops from producing regions to domestic and/or foreign importing regions. The criterion used in the model is to minimize production costs of the crops produced in exporting countries and marketing costs of shipping the crops from each producing region in exporting countries to domestic consuming regions in the importing countries. The model is optimized subject to a system of linear constraints, including arable land in producing regions and demand for each crop in domestic and foreign importing regions.

The model consists of six exporting countries and 64 importing countries divided into 17 importing regions. Of the six exporting countries, the United States has 18 producing regions; Canada has three producing regions; Argentina, Brazil, Australia, and France each have one producing region. The exporting countries also are divided into domestic consuming regions. The United States is divided into 24 regions; Canada, two regions; and all other exporters, one region. U.S. consuming regions were chosen by location of wheat and corn mills and soybean processing plants. Other countries' domestic consuming regions were determined as urban centers with the greatest population.

Trade originates from ports within each exporting country. The model includes five exporting ports in the United States, two in Canada, and one in each of the other countries. Importing centers for all regions were chosen as centralized positions based on distance.

DATA

The model requires costs associated with production activities (production costs), costs associated with domestic transportation activities (barge and rail costs), costs associa-

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ted with exports (ocean shipping costs), yields, arable land available in producing regions, demand in domestic consuming regions, and import demands in foreign countries.

Production costs are reported as average total costs to produce one hectare of crop. Only variable costs of crop production are considered in this study because it analyzes short-run spatial equilibrium. Production cost data were obtained from McElroy (10), Stanton (13), Strain and Bawdry (14) and Ortman et al (12). Production yield data used in this study are a three-year average, 1984-1986. The data were obtained from the above publications.

Marketing costs consist of shipping costs from producing regions to final destinations and handling costs at elevators and port terminals. The handling costs used are 12 cents per bushel at country elevators and 7 cents per bushel at port terminals. Shipping costs are divided into two components: 1) costs from producing regions to domestic consuming regions and 2) costs from producing regions to foreign importing regions through port terminals. Grains assumably are moved to domestic consuming regions by rail or truck, to port terminals by rail, barge, truck or a combination of these, and to importing regions by ocean vessels.

Rail, barge, and truck rates (for the United States and Canada) were obtained from a study by Koo and Thompson (9) and were adjusted to 1986 United States prices for the rates in the United States and adjusted to 1986 Canadian prices for the rates in Canada. For other exporting countries, marketing costs are the sum of the average transportation rates from a central production location to the port terminal and the handling charge at the port. The marketing costs in each exporting country are converted to 1986 dollars by using the average exchange rates (7).

Sources for ocean freight rates needed for this study were not available. Accordingly, an ocean freight rate function was developed using the average of 57 shipping rates reported in *World Wheat Statistics* (8). These freight rates were regressed against one-way mileage to produce the following equation:

$$OFC_{in} = 14.668 + 0.00156 M_{in}$$
$$(89.09)$$
$$R^2 = 0.533$$

where M_{in} is a one-way mileage from the ith export port to the nth import region, and OFC_{in} is ocean freight rates from the ith export port to the nth import region. The t-value (the number of parenthesis) indicates that one-way mileage is statistically significant at the 1 percent level.

The shortest distance between exporting and importing ports was calculated (3), then ocean freights rates were calculated by using the above Equation.

To calculate average available land for wheat and corn in each producing region in the United States, the set-aside acreage was added to total harvested acres of wheat and corn. These totals were added to soybean harvested acreage. A three-year average from 1984 to 1986 was calculated and converted to hectares for this study.

Total available land in other exporting countries was defined as being 25 percent larger than average harvested acres for wheat, corn, and soybeans from 1984 to 1986. All data were taken from the *FAO Yearbook of Production* (5) and *Agriculture Canada* (1).

Total U.S. demand for 1984 to 1986 was taken from *USDA Situation Outlook* reports for wheat, corn, and soybeans (15). A three-year average was calculated and allocated to each consuming region on the basis of the total milling capacity in each region for food uses and the number of grain consuming animal units for feed uses. Total demand for wheat in Canada was based on data reported in *World Wheat Statistics* (8). A three-year average from 1984 to 1986 was calculated and allocated to two consuming regions on the basis of Canadian milling capacity for spring wheat (4). Domestic demand for wheat in Argentina, Australia, and France was obtained from *World Wheat Situation* (8). Data for corn and soybeans in these countries were calculated simply as production less exports assuming that beginning stocks are a small portion of total supply.

Total imports for all importing regions were collected from various years of the *FAO Trade Yearbook* (5). Annual imports for all countries in a given importing region were aggregated for the years 1983 to 1985 for corn and soybeans. These totals were averaged to obtain total average imports for each region by crop. Wheat imports for all importing regions were based on data reported in *World Wheat Statistics* (8).

RESULTS

Table 1 presents optimal quantities of each crop produced in producing regions in the United States, Canada, and other exporting countries. The total HRW wheat production is 44 million metric tons (mmt) in the United States, 12 mmt in Argentina, and 6.4 mmt in Brazil. The actual HRW wheat production in the United States was 28 mmt in 1986, implying that the United States should produce more HRW wheat than the current production level based on production and marketing costs. The total spring wheat production is 11 mmt in the United States and 26 mmt in Canada. The actual production in 1986 was 15 mmt in the United States and 24 mmt in Canada. On the other hand, the United States produces 13 mmt of soft wheat, which is much larger than the actual production in 1986. France produces 22 mmt of soft wheat and Australia 16 mmt.

Corn production is largely concentrated in Iowa, Illinois, Nebraska, Minnesota, Wisconsin, Michigan, Indiana, and Ohio. The total quantities of corn produced are 217 mmt in the United States, 6.8 mmt in France, 7.2 mmt in Argentina, and 20.7 mmt in Brazil. The optimal corn production in the United States is similar to actual production in 1986.

Soybean production is concentrated in Iowa, Illinois, Indiana, and Ohio. The total soybean production in the United States in 58 mmt, which is similar to actual production in 1986. Brazil produces 14 mmt of soybeans and Argentina 4.3 mmt.

Table 1. Total production by crops in the U.S. and other exporting countries in the base model.

Region	Production						Utilization of Arable Land			
	HRW	Spring	Soft	Corn	Soybean	Total	Total Land	Land Used	Unused Land	Unused Land
										(% of)
1. WA, OR	—	—	3,663	—	—	3,663	2,884	1,009	1,875	65.4
2. CA, NV, UT, AR	2,571	—	—	3,469	—	6,040	1,404	816	588	42.4
3. MT, ID, WY	3,041	3,186	199	—	—	6,426	5,988	4,197	1,790	29.3
4. CO	4,631	—	—	1,808	—	6,439	2,590	2,359	230	0.9
5. ND	275	4,782	—	989	190	6,236	5,579	2,411	3,168	57.0
6. SD	842	892	—	3,597	1,004	6,335	5,579	2,411	3,168	57.0
7. NE	3,393	—	—	32,385	1,174	36,952	6,950	6,514	436	6.1
8. KS	15,954	—	—	1,969	1,284	19,207	9,689	8,301	1,388	14.3
9. OK	4,152	—	—	—	—	4,152	4,404	2,844	1,560	35.6
10. TX, NM	5,447	—	—	2,740	—	8,187	7,643	2,675	4,968	65.2
11. MN	360	1,706	—	26,987	6,273	35,326	366	7,571	7,937	5.4
12. IA, IL	—	—	1,821	75,222	26,856	103,899	19,854	19,854	0	0
13. ARK, LA, MS, MO	—	—	—	8,597	6,168	14,765	10,131	4,788	5,344	53.9
14. WI, MI	—	—	2,020	25,366	729	28,115	4,806	4,806	0	0
15. IN, OH	—	—	3,681	20,218	10,513	34,412	9,048	8,275	773	8.3
16. KY, TN, WV, VA, NC	—	—	817	6,815	2,082	9,714	4,972	3,027	1,945	39.2
17. AL, GA, SC, FL	—	—	—	4,876	1,409	6,285	4,138	2,043	2,095	51.1
18. NY, PA, NJ, MD, DE	—	—	1,030	1,492	675	3,197	2,788	975	1,813	65.4
US TOTAL	40,666	10,566	13,231	216,530	58,357	339,350	8,683	85,222	33,461	28.2
Canada	—	26,197	—	—	—	26,197	6,159	14,492	1,667	10.3
AL	—	4,505	—	—	—	4,505	2,371	2,371	0	0
SA	—	17,358	—	—	—	17,358	10,151	10,151	0	0
MAN	—	4,334	—	—	—	4,334	3,637	1,970	1,667	46.8
France	—	—	21,669	6,772	—	28,471	8,116	14,396	3,720	45.8
Argentina	11,731	—	—	7,224	4,313	23,268	14,573	10,525	4,048	27.7
Australia	—	—	15,799	—	—	15,799	14,116	10,193	3,923	27.8
Brazil	6,432	—	—	20,702	13,863	40,997	29,908	22,669	7,239	24.2
TOTAL	58,829	36,763	50,729	251,228	76,533	474,082	199,555	147,497	52,058	26.1

Arable land for crop production also is shown in Table 1. A ratio of land used for crop production to the total arable land in a producing region indicates the region's competitive advantage in producing and marketing agricultural products. On the other hand, a ratio of unused land to the total arable land in a producing region is interpreted as the region's competitive disadvantage in producing and marketing agricultural products. The total acres of arable land are used fully in Iowa, Illinois, Wisconsin, and Michigan, indicating that these states have a competitive advantage over other states and countries in producing and marketing agricultural products. In Canada, the total acres of arable land are used fully in Alberta and Saskatchewan.

The percentage of the unused land is high in Washington (65.4 percent), Oregon (65.4 percent), North Dakota (65.2 percent), South Dakota (57.9 percent), and New England (65.2 percent), indicating that these states have a competitive disadvantage over other states and countries in producing and marketing agricultural products. The disadvantage can be interpreted as follows: 1) these states may have reduced production of agricultural products or 2) farmers in these states should accept lower prices of agricultural products than those farmers in other states receive to maintain the production level. If free trade is implemented fully, these states may have a major setback in their agricultural economy. The total acres of unused land is 28.2 percent of the total arable land in the United States, 10.3 percent in Canada, 27.8 percent in Australia, 45.8 percent in France, 24.2 percent in Brazil, and 27.7 percent in Argentina. This implies that France has a comparative disadvantage in producing and exporting agricultural products and Canada has an advantage mainly in HRS wheat production.

Exporting countries' market shares of each crop are shown in Table 2. Based on production and marketing costs, the U.S. market shares are 81 percent for HRW wheat, 93.5 percent for corn, and 93.9 percent for soybeans, more than the actual market shares in 1986. This implies that the United States could increase its market shares of HRW wheat, corn, and soybeans if production and marketing costs determine world trade under a free trade system. The optimal market shares for spring wheat and soft wheat in the United States are 15.3 percent and 20.5 percent, respectively, which are smaller than the actual market shares in 1986. The United States could lose its market shares of spring wheat and soft wheat to Canada and Australia, respectively, under a free trade system.

CONCLUDING REMARKS

A spatial equilibrium trade model was developed to evaluate competitiveness of U.S. agricultural products (HRW, spring, soft, corn, and soybean) in the world market on the basis of principles of comparative and competitive advantage in terms of production and marketing costs.

This study found that the United States has a comparative and competitive advantage in producing and marketing HRW wheat, corn, and soybeans over other countries and has a disadvantage in producing spring and soft wheat. In the United States, Iowa, Illinois, Wisconsin, and Michigan have a greater advantage in producing and marketing agricultural products while the Dakotas, Washington, Oregon, and New England have a comparative disadvantage in producing and marketing agricultural products.

Table 2. Quantities of crops exported by countries.

Country	HRW	Spring	Soft	Corn	Soybean	Total
United States	25,459 (81.1)	3,723 (15.3)	4,969 (20.5)	43,759 (93.5)	28,599 (93.9)	106,506 (67.8)
Canada	—	20,586 (84.7)	—	—	—	20,587 (13.1)
France	—	—	4,006 (16.5)	—	—	4,006 (2.5)
Brazil	—	—	—	—	—	
Australia	—	—	15,251 (63.0)	—	—	15,251 (9.7)
Argentina	5,929 (18.9)	—	—	3,044 (6.5)	1,861 (6.1)	10,834 (6.9)
Total	31,386	24,309	24,225	46,803	30,459	157,183

This disadvantage is mainly because of higher marketing costs rather than production costs. If free trade is implemented, these states, including North Dakota, may either have to reduce production of agricultural products or may have to lower prices of agricultural products to maintain their production levels. In other words, free trade for agricultural products may affect agricultural economies negatively in the states which have a comparative disadvantage in producing and marketing agricultural products while it may affect the overall U.S. economy positively.

Some policy alternatives for those states, including North Dakota, under free trade for agricultural products include the following:

1) to increase exports of value-added products, which not only will reduce locational disadvantage but also will increase economic activity in rural communities;

2) to differentiate agricultural products produced in North Dakota from those produced in other states, e.g., better quality and services. This is a way to maintain market shares under a free market system;

3) to produce specialty crops in which North Dakota has a comparative advantage over other states, and

4) to develop a bilateral trade relationship with individual importing countries for value-added products and specialty crops.

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