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Spatial Equilibrium Analysis of the World Wheat Market Under Alternative Trade Policies

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Highlights

A spatial programming model was used to evaluate international competition among the United States, Canada, Mexico, the European Community (EC), Eastern Europe, Argentina, and Australia in the production and export of wheat. The model divides wheat into four classes: soft red winter (SRW), hard red winter (HRW), hard red spring (HRS), and durum. The model includes tariffs among the United States, Canada, and Mexico as well as Mexico's import license. The model also includes domestic production subsidies, export subsidies, and credit and long-term agreements (LTAs) exporting countries use.

The objective of the model is to minimize wheat production costs at production regions, distribution costs of wheat from production regions to utilization centers or ports for export, and distribution costs of wheat from export ports to importing regions' ports. The objective function is optimized, subject to the following constraints: 1) upper limit on land acreage planted to all classes of wheat, 2) equilibrium condition at each production region, 3) demand for each class of wheat at utilization centers, 4) import demand for each class of wheat by importing region, and 5) inventory cleaning conditions at export and import ports.

This study indicates production subsidies are important to U.S. production of both HRW and SRW. Argentina and Australia both would benefit if the United States, Canada, and the EC decreased production subsidies. U.S. durum and HRS production would increase, while both Canadian and EC production of durum would decrease.

Removing credit and LTAs causes U.S., EC, and Argentinean's exports to decrease while Canada's exports increase and Australian exports remain unchanged. EC exports decrease 60 percent when export subsidies are removed. U.S. exports decrease four percent, Canadian exports increase two percent, and both Argentinean and Australian exports double.

The North American Free Trade Agreement (NAFTA) increases U.S. and Canadian exports of durum and HRS, mostly to Mexico. U.S. exports of SRW to Mexico increase, reducing the number of other import markets the United States can supply. The result is an increase in EC exports of SRW to import markets the United States formerly served.

World free trade would reduce both U.S. and EC exports and increase Canadian, Australian, and Argentinean exports. Both U.S. and Canadian durum exports would increase; however, only U.S. HRS exports would increase while Canada's would remain unchanged. EC exports of both SRW and durum would decrease. U.S. exports of SRW would decrease while Argentina would increase exports of its wheat into SRW import markets the EC formerly served. U.S. exports of HRW would decrease the most while Australian exports of HRW would increase three and a half times.

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Introduction

The world wheat market has changed dramatically in the past decade. Farm support policies in exporting and importing countries have encouraged production, resulting in large stock buildups. Countries use quotas, variable levies, and other forms of import restrictions to protect domestic producers. As world trade decreased during the early 1980s from a depressed world economy, major exporting countries expanded the use of export subsidies to maintain or gain market share.

Escalating budget costs of maintaining farm support programs and export subsidies have been important to policy reform. Farm program costs tripled for the United States from 1981 to 1988 to $12.5 billion while the budget cost of farm subsidies and related supports in the European Community (EC) doubled over the same period to $32 billion (Harwood and Bailey, 1990). This situation made agriculture a priority at the Uruguay Round negotiations. A need was recognized to focus on domestic farm programs since many distortions in international trade result from farm support programs.

The primary objective of this study is to determine how changing or eliminating domestic production and trade subsidies and other trade promotion policies will affect international wheat trade. Specific objectives are

1. To analyze the impacts of export promotion and production subsidy programs that exporting countries use for wheat production in exporting countries and trade flows.

2. To evaluate the potential impacts of NAFTA on production and trade flows of wheat in North America.

3. To analyze the impact of world free trade on wheat production in exporting countries and trade flows.

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World Wheat Market

Five countries account for the majority of the world's wheat exports (Table 1). The United States accounted for about 30 percent of wheat exports between 1984/85 and 1991/92. Canada and the EC were virtually equal in wheat exports. Argentina and Australia, especially the latter, reduced wheat exports because of lower domestic and export subsidies relative to the United States, Canada, and the EC.

Wheat can be divided into three classes: hard wheat, soft wheat, and durum, based on quality characteristics and end use. Different wheat classes have unique qualities and characteristics that affect their end use in different countries and, therefore, influence trade flows. The white and SRW wheats can be substituted in the production of flat breads and noodles as can HRW and HRS wheat in the production of pan bread (Harwood and Young). Substitution is unlikely in the case of durum, which is used to produce high grade pasta and which the North African countries use for couscous.

The United States produces all three classes of wheat. Soft Red Winter (SRW) wheat is produced along and east of the Mississippi River, Hard Red Spring (HRS) wheat and durum are grown primarily in North Dakota, and Hard Red Winter (HRW) is grown primarily in the central plains, particularly Kansas (USDA, ERS, Wheat Situation). White wheat, which is a type of soft wheat, is grown in the Pacific Northwest.

Average U.S. wheat acreage (1986, 87, and 89 average)[1] was 56.75 million acres with 27.65 million acres in HRW, 13.93 million acres in HRS, 11.94 million acres in SRW (including white wheat), and 3.23 million acres in durum (Table 2).

The majority of Canadian wheat is produced in Saskatchewan, southwestern Manitoba, and southeastern Alberta. Canada produces primarily HRS wheat (Canadian Western Red Spring) and durum. Canada's wheat acreage included 26.82 million acres of HRS and 5.47 million acres of durum (1986, 87, and 89 average).

The EC produced 33.05 million acres of a soft wheat and 6.8 million acres of durum. France accounted for 40 percent of SRW acreage in the EC for 1990. Germany and the United Kingdom are also major producers. The majority of durum is produced in Italy, Greece, and France. Italy accounted for nearly 60 percent of EC durum acreage in 1990 followed by 22 percent for Greece and 13 percent for France.

Eastern Europe produces 24.6 million acres of soft wheat. Wheat acreage is dispersed equally throughout Eastern Europe among Poland, Romania, Hungary, Czechoslovakia, and Yugoslavia.

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[1]1988 was excluded due to the drought which occurred in that year.

TABLE 1. WHEAT EXPORTS BY MAJOR EXPORTING COUNTRIES, 1984/85 - 1991/92

	Marketing Year (July/June)							
Country	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92
	---------------------- Million Metric Tons ----------------------							
United States	38.1	25.0	28.4	43.4	37.6	33.5	28.3	34.7
Canada	19.4	16.8	20.8	23.6	13.5	17.0	20.6	24.0
E.C.	18.6	15.7	16.5	14.8	21.0	21.0	20.0	23.0
Argentina	8.0	6.1	4.3	3.8	3.5	5.6	4.7	5.5
Australia	15.8	16.0	14.8	12.2	10.8	10.8	11.8	7.1
Total	99.9	79.6	84.8	97.8	86.4	87.9	85.4	94.3
World Total	107.0	84.8	91.3	106.1	97.2	96.1	93.1	107.7

SOURCE: USDA, FAS, "World Grain Situation and Outlook." 1992.

TABLE 2. WHEAT ACREAGE BY CLASS OF WHEAT AND TOTAL WHEAT ACREAGE, BY COUNTRY, AVERAGE 1986, 1987, AND 1989

	Wheat Class				
Country	SRW	HRS	HRW	Durum	Total
	------------Million Acres---------------				
United States	11.94	13.93	27.65	3.23	56.75
Canada	--	26.82	--	5.47	32.29
Mexico	1.61	--	--	0.18	1.79
European Community	33.05	--	--	6.80	39.85
Eastern Europe	24.60	--	--	--	24.60
Australia	--	--	22.21	--	22.21
Argentina	--	--	12.43	--	12.43

SOURCE: U.S. acreage from USDA, National Agricultural Statistics Service. Canadian acreage from Statistics Canada, Agriculture Division. All other acreages from International Wheat Council.

Australia primarily produces white winter wheat which is similar to HRW in terms of quality and characteristics (Ortmann et al.). Australian wheat acreage amounted to 22.21 million acres (Table 2). Wheat acreage is concentrated in the eastern Australian states of New South Wales and Victoria.

Argentina produces a wheat with characteristics of both soft and hard wheat (Harwood and Bailey). Argentina's wheat acreage amounted to 12.43 million acres (Table 2).

Most of the nearly 30 million metric tons (mmt) of U.S. export of wheat were SRW and HRW wheat (Table 3). The United States competes with the EC for market share of SRW exports. Major U.S. markets for SRW wheat include China, West Asia, and the North African markets. EC markets for SRW wheat include the Former Soviet Union (FSU), China, West Asia, and the North African markets.

Canada is the leader in exports of HRS wheat and durum. The United States also exports HRS wheat while both the United States and the EC compete with Canada for market share of durum exports. Major U.S. markets for HRS wheat include Southeast Asia and the east Asian markets (Japan and South Korea). Major Canadian markets for HRS wheat include China, the FSU, and the east Asian markets. The United States, Canada, and the EC intensely compete for the North African durum market.

TABLE 3. WHEAT EXPORTS BY CLASS OF WHEAT AND TOTAL WHEAT EXPORTS, BY COUNTRY, AVERAGE 1986, 1987, AND 1989

	Wheat Class				
Country	SRW	HRS	HRW	Durum	Total
	-----------Million Metric Tons----------				
United States	13.17	5.11	10.69	0.94	29.91
Canada	--	12.55	--	2.31	14.86
European Community[1]	16.30	--	--	1.13	17.43
Eastern Europe	5.67	--	--	--	5.67
Australia	--	--	10.47	--	10.47
Argentina	--	--	5.53	--	5.53

[1] Excludes Intra-EC trade.

SOURCE: U.S., E.C., and Argentina exports from FAS, "U.S. Export Sales," Various issues. Canadian exports from Canadian Wheat Board. Australian exports from Australian Wheat Board. EC exports also from International Wheat Council and Eurostat.

Australia and Argentina compete with the United States in exporting HRW wheat. Major U.S. markets for HRW wheat include the FSU, China, and the east Asian markets. Argentina's major markets are South American countries and West Asia. Australia's major markets are the North African countries, China, the FSU, and West Asia.

Export Policies

The major exporting countries use several export promotion policies, including export subsidies, credit arrangements, and long-term agreements to protect or enhance their positions in the world market.

Export Subsidies

The EC and the United States are the primary users of direct export subsidies. The EC subsidy is equal to the difference between the EC market price and the world price. The EC's system of target, threshold, and intervention prices keeps market prices well above the world price.

The EC uses two methods to establish export restitutions. First, refund tenders cover the majority of EC exports in which traders apply for refunds on specific quantities exported to specific markets. The exporter receives an export certificate, indicating the refund and a time period within which the certificate is valid. The second method is the "ordinary restitution" and is published regularly. These refunds are designated for particular destinations and often are used for stable import markets. Restitutions are the same for every origin of wheat in the EC, but may differ depending on destination.

The United States instituted export subsidies under the Export Enhancement Program (EEP) in May 1985 to regain lost market share and compete with EC subsidies. The EEP uses a competitive bid process under which the U.S. Department of Agriculture targets a country for a specific quantity of a commodity. U.S. exporters then compete for sales to the targeted market, and bonuses are awarded to the exporter(s) whose sales price and bonus bid fall within an acceptable range. The EEP bonus is calculated by taking the difference between the U.S. market price and world price. The exporter completes the sale, presents proof of delivery, and receives a cash subsidy. The exporter may sell these certificates or exchange them for CCC stocks.

Sales targeted to the FSU and China account for half of EEP wheat sales, and sales to the North African and Middle eastern countries account for one-third of EEP wheat sales.

The Canadian rail subsidy under the Western Grain Transportation Act (WGTA) provides direct government payments to Canadian railroads for shipments of specified commodities, including wheat (U.S. International Trade Commission). Rail shipments subject to this subsidy include those from any point west of Thunder Bay, Ontario, or Armstrong, Ontario, to

1. Thunder Bay or Armstrong for export or domestic use

2. any port in British Columbia for export (except to the United States)

3. Churchill, Manitoba, for export.

The WGTA rail subsidy was estimated at $21.31 per metric ton, which was equivalent to 70 percent of the estimated freight rate of $30.31 per metric ton in 1989-90 (U.S. International Trade Commission).

Export Credit

The United States, the Canadian Wheat Board (CWB), the Australian Wheat Board (AWB), and Argentina offer export credit. The EC does not offer credit assistance as a community; however some member countries do. France guarantees repayment through COFACE and certain commercial banks.

The credit terms and conditions vary widely across countries. Argentina's credit has primarily been granted to other Latin American countries, including Peru and Cuba, and has not exceeded 12 months. Australia extends credit through the AWB for up to three years. Egypt and Iraq are regular recipients with the AWB, and indirectly, the wheat growers bearing any costs. The Canadian government guarantees loan repayment on credit extended which does not exceed three years. Brazil is the largest credit buyer of wheat, followed by Iraq, Egypt, and Algeria.

France's COFACE provides short-term credit and guarantees 85 percent of the credit if the purchaser is a private buyer and 90 percent if the purchaser is a foreign government. Medium- and long-term credit financing is provided through the Banque Francaise du Commerce Exterieur. The U.S. Department of Agriculture operates two credit programs: GSM-102 and GSM-103. The GSM-102 program guarantees repayment of private credit extended to importers in specified countries for up to three years. The GSM-103 program covers private credit extended for between three and 10 years.

Long-term Agreements

Long-term agreements (LTAs) are advantageous to both exporting and importing countries. Exporting countries use LTAs to maintain export shares, attain new markets, and stabilize exports from year to year. Importers use LTAs to assure reliable supplies. LTAs include provisions for an upper and lower bound on purchases and in some cases, financing arrangements and involve shipments over two or more seasons. Historically, 75 percent of the FSU's wheat imports were through LTAs.

Canada and Australia have an advantage in negotiating LTAs because their grain boards can guarantee these trade commitments. Actual LTA shipments account for a small share of U.S. wheat exports (Harwood and Bailey, 1990).

North American Free Trade Agreement

The United States produced 74.5 mmt of wheat in 1990, Canada 31.7 mmt, and Mexico 3.9 mmt. Mexico has one of the highest average wheat yields in the world because of the adoption of semi-dwarf wheat varieties grown on irrigated land; about 90 percent of the wheat crop is grown on irrigated land. Mexican wheat yields averaged 61 bushels per acre (1985-89) compared to 35 bushels per acre for the United States.

About 80 percent of Mexican wheat production is soft wheat and 20 percent durum varieties. Mexico's wheat imports consist primarily of hard red wheat but have been erratic over the past decade. The United States is the major exporter of wheat to Mexico, accounting for 65 percent of Mexico's wheat imports between 1985 and 1990. Canada is the major competitor in exporting wheat to Mexico. Both U.S. and Canadian sales of wheat to Mexico are made under credit.

Wheat trade between the United States and Canada has increased, primarily because of the U.S.-Canadian Free Trade Agreement. The agreement eliminated Canada's import license for wheat. Since the agreement was ratified, Canadian durum exports to the United States have increased. The increased flow of Canadian durum into the United States from Canada is a controversial issue between the two countries. The Canadian rail subsidy to Thunder Bay may give Canada an unfair advantage in the eventual export of durum to the United States. The increased flow of Canadian durum to the United States may also be a result of U.S. and EC export subsidies which depress world prices below domestic prices in the United States, therefore making it more profitable to sell Canadian durum in the U.S. market.

The NAFTA would reduce trade barriers among the United States, Canada, and Mexico. The United States would phase out a 0.77 cents per kilogram tariff on durum wheat from Mexico over 10 years; for other wheat this tariff would be reduced to zero over five years. Mexico would convert its import license for wheat imported from the United States and Canada to tariffs. U.S. wheat exports to Mexico would be subject to a 15 percent tariff to be reduced in equal installments over a 10 year period. In addition Canada would eliminate its import license on wheat imported from Mexico.

Model Development

The model used for this study is a static spatial programming model based on a mathematical programming algorithm. The model includes four classes of wheat (hard wheat is further divided into HRS and HRW): HRS, HRW, SRW, and durum. The objective of the model is to minimize production costs of wheat at production regions, transportation costs from production regions to utilization centers and ports for export, and ocean shipping costs from export to import ports.

Quantities of wheat produced in each region, quantities shipped to utilization centers and ports, and quantities shipped for export are endogenous variables. The model includes seven exporting countries and 12 importing regions, representing 50 importing countries (Table 4). Mexico, Eastern Europe, and the EC are allowed to import and export wheat based on the least-cost alternative.

TABLE 4. IMPORT REGIONS AND COMPOSITION OF EACH IMPORT REGION

Import Region	Composition
Northeast Africa	Egypt, Libya
Northwest Africa	Algeria, Morocco, Tunisia
China	China
South Asia	Afghanistan, Bangladesh, India, Pakistan, Sri Lanka
Southeast Asia	Singapore, Vietnam, Indonesia, Hong Kong, Thailand, Malaysia, Philippines
West Asia	Turkey, Bahrain, Cyprus, Israel, Iran, Iraq, Kuwait, Lebanon, North and South Yemen, Oman, Qatar, Syria, UAE
East Asia	Japan, South Korea
Former Soviet Union	USSR
Western Europe	Finland, Norway
Western South America	Columbia, Ecuador, Peru
Northern South America	Venezuela, Guyana
Eastern South America	Brazil, Uruguay, Bolivia

The United States is divided into 37 production regions, 31 utilization centers, and has six export ports (Figure 1)[2]. Canada is divided into seven production regions, six utilization centers, and has two ports (Figure 1). Mexico is divided into five production regions and four utilization centers (Figure 2). Mexico export activities are limited to the United States by rail. The EC is divided into three production regions, six utilization centers, and has four export ports (Figure 3). Eastern Europe has one production region, three utilization centers, and one export port (Figure 3). Trade flows between the EC and Eastern Europe move by rail or ocean vessel.

Australia has two each of production regions, utilization centers, and export ports (Figure 4). Argentina has one production region, utilization center, and export port (Figure 4). Utilization centers in the United States and Canada were chosen by location of wheat mills. Other countries' utilization centers were chosen as urban centers with the most population.

[2]Utilization centers by country are not included in the figures.

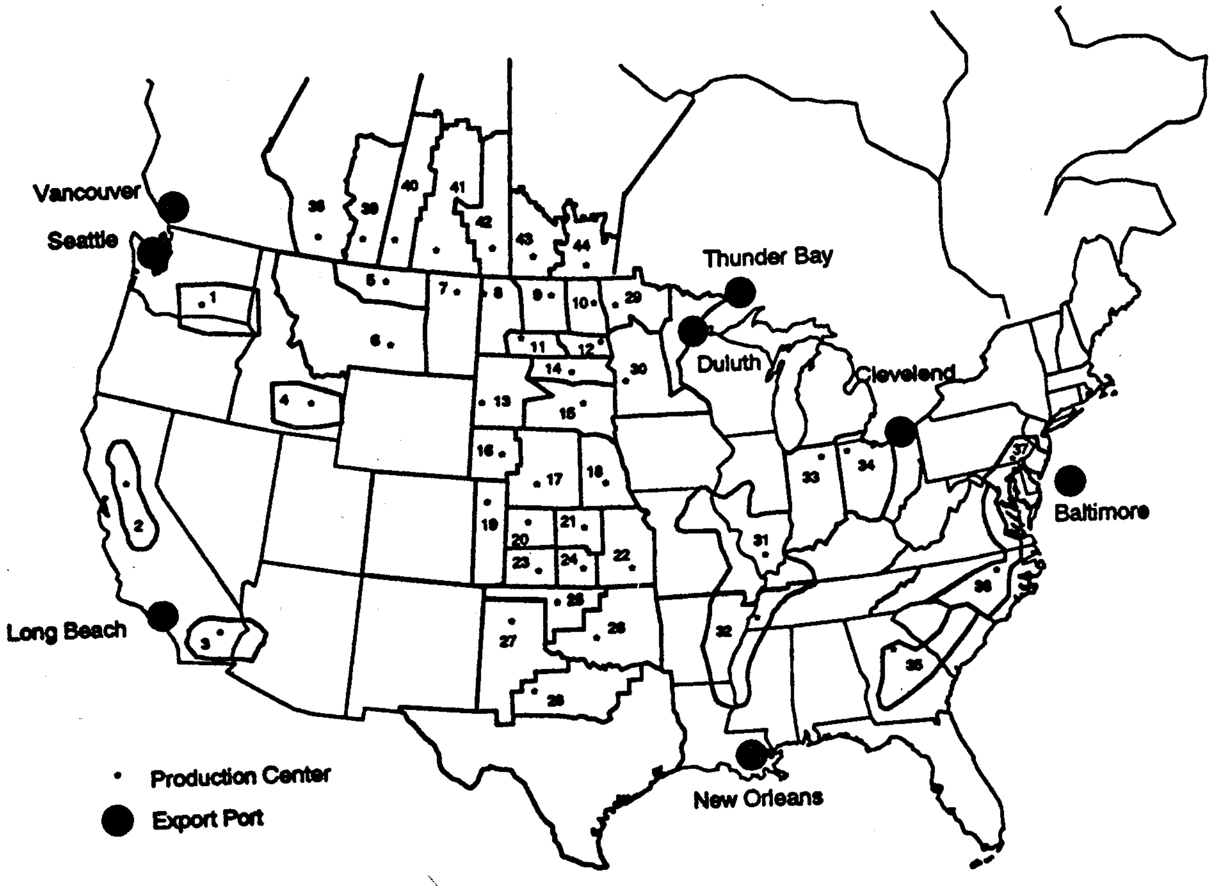

Figure 1. Production Regions and Export Ports for the United States and Canada

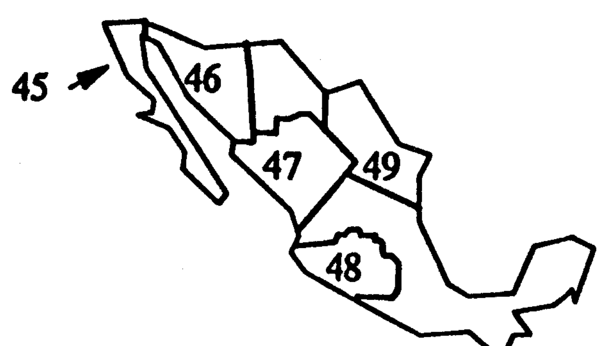

Figure 2. Production Regions for Mexico

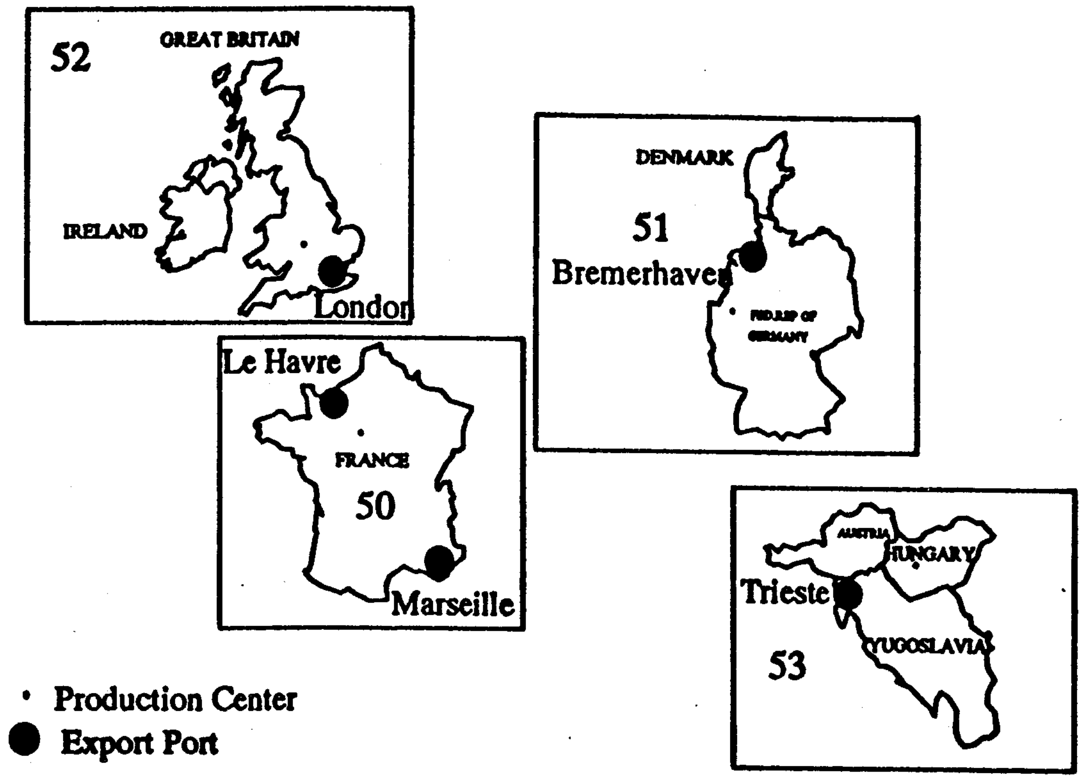

Figure 3. Production Regions and Export Ports for Europe

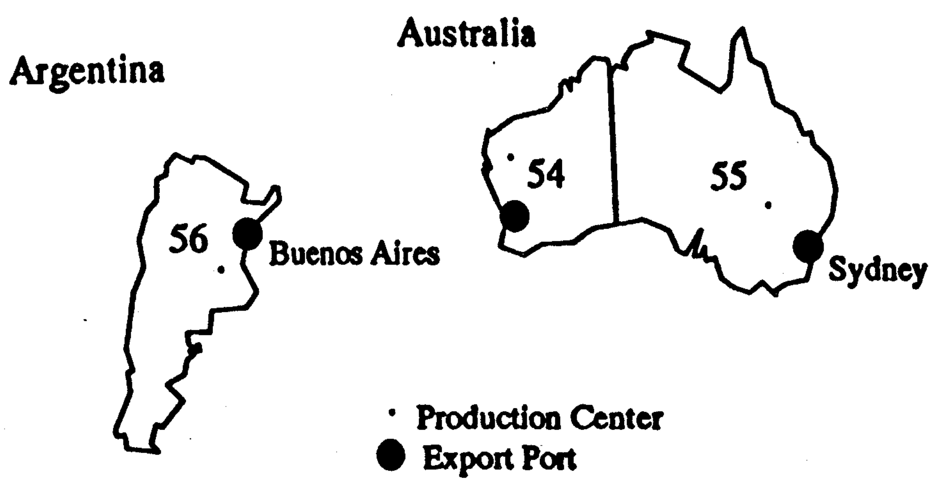

Figure 4. Production Regions and Export Ports for Argentina and Australia

Assumptions used to develop the model are as follows:

1. Both domestic and import demand for wheat are assumed to be perfectly inelastic in the model.

2. The model does not have storage activities at ports, implying that all wheat received at ports must be exported.

3. The mode of domestic transportation from production regions to utilization centers and export ports is rail.

4. Wheat moved to ports is shipped to importing regions on ocean vessels.

The objective function of the model is written as follows:

$$\text{Min } Z = \sum_{c=1}^{4}\sum_{i=1}^{I} PC_{ic}\,A_{ic} + \sum_{c=1}^{4}\sum_{i=1}^{I}\sum_{j=1}^{J} t_{cij}\,Q_{cij} + \sum_{c=1}^{4}\sum_{i=1}^{I}\sum_{p=1}^{P} t_{cip}\,Q_{cip} + \sum_{c=1}^{4}\sum_{p=1}^{P}\sum_{n=1}^{N} t_{cpn}\,Q_{cpn} + \sum_{c=1}^{4}\sum_{p=1}^{P}\sum_{s=1}^{S} t_{cps}\,Q_{cps} + \sum_{c=1}^{4}\sum_{s=1}^{S}\sum_{j=1}^{J} t_{csj}\,Q_{csj} \quad (1)$$

where

c = index representing class of wheat
i = index of production region
j = index for utilization centers
p = index for export ports
n = index for importing ports
s = index for import ports in Europe
PC = production cost per acre in production region i
A = acres planted in production region i
t = transportation cost per metric ton of shipping wheat
Q = metric tons of wheat being transported

The objective function in equation 1 is the summation of six separate activities. The first summation represents the total production cost to produce each class of wheat. The five remaining summations associated with shipments of wheat are (1) shipments of wheat from production regions to utilization centers, (2) shipments of wheat from production regions to export ports, (3) shipments of wheat from export ports to ports of importing regions, (4) shipments of wheat from export ports to import ports in Europe, and (5) shipments of wheat from European import ports to European utilization centers. European imports are treated as a separate activity from other importing regions because Europe is allowed to produce wheat unlike other importing regions.

Six linear constraints are placed on equation 1 as follows:

$$UL_i \geq \sum_{c=1}^{L} A_{ci} \tag{2}$$

$$Y_{ci} * A_{ci} \geq \sum_{j=1}^{J} Q_{cij} + \sum_{p=1}^{P} Q_{cip} \tag{3}$$

$$D_{cj} \leq \sum_{i=1}^{I} Q_{cij} + \sum_{s=1}^{S} Q_{csj} \tag{4}$$

$$MD_{cn} \leq \sum_{p=1}^{P} Q_{cpn} \tag{5}$$

$$\sum_{i=1}^{I} Q_{cip} = \sum_{n=1}^{N} Q_{cpn} + \sum_{s=1}^{S} Q_{cps} \tag{6}$$

$$\sum_{p=1}^{P} Q_{cps} = \sum_{j=1}^{J} Q_{csj} \tag{7}$$

where

UL_i = maximum acres of land available for wheat production
Y_{ci} = wheat yield per acre by wheat class in production region i
MD_{cn} = import demand by wheat class in import region n

Equation 2 represents land constraints for wheat production. The sum of acres planted into each class of wheat should be less than or equal to the upper limit of available land. Equation 3 refers to supply constraints, indicating that the total quantity of each class of wheat produced in each production region is greater than or equal to the quantity shipped to utilization centers and export ports.

Equation 4 represents demand for each class of wheat at each utilization center. Equation 5 represents import demand at each importing country. The total amount of each class of wheat shipped from export ports to importing regions should be greater than or equal to the quantity of that class of wheat demanded at that region. Equation 6 is an inventory clearing condition at export ports. Equation 6 forces all wheat moved to export ports to be shipped to import ports. Equation 7 is an inventory clearing condition at European import ports. All wheat shipped to European import ports must be moved to European utilization centers.

Policy Simulations

The base model optimizes wheat production and trade flows with existing trade policies of exporting and importing countries. Trade policies included in the base model are import tariffs imposed among the United States, Canada, and Mexico; the Mexican import license; producer subsidy equivalents (PSE)[3] applied to domestic production; and export promotion programs (export credit, export subsidies, and LTAs). Tariffs importing countries use are not included in this study because they are applied evenly to all exporting countries under GATT rules to avoid preferential treatment, and thus, would not alter trade flows. The EC's import levy is not included in the model which may impact trade flows. The base model solution is compared with solutions of alternative models in terms of acreage and export volume by wheat class.

The base and alternative models are as follows:

1. Model 1 is the base model described above with the existing trade restricting policies.

2. Model 2 is the base model without the PSE for domestic production in each country.

3. Model 3 is the base model without export credits and LTAs.

4. Model 4 is the base model without export subsidies in each exporting country.

5. Model 5 is the base model without export promotion programs (export subsidies, credit, and LTAs).

6. Model 6 is the base model without trade barriers among the United States, Canada, and Mexico.

7. Model 7 is a free trade model, excluding all trade barriers and subsidies.

Data

The model requires costs associated with production activities (production costs), domestic transportation activities (rail rates), and export activities (ocean freight rates), average yields in production regions, and right-hand side values

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[3]PSE is defined as the total transfers from government programs divided by a commodity's market value plus any direct government payments, such as deficiency payments. For a further explanation see Webb et al., page 2.

associated with constraints (wheat acreage, domestic utilization, foreign import demand, credit, and LTAs).

Production Costs and Yield

Production costs for classes of wheat in exporting countries are total economic costs less net land return. Farm subsidy programs and economic conditions in a country distort the value of land. Land values do not represent productivity and differ according to policies among exporting countries.

Production costs by production region for the United States were based on state production costs (McElroy 1987). Production costs were calculated as an average of state production costs for a production region consisting of two or more states (Table 5).

Canadian production costs were based on soil zones within each province (Table 5, Strain and Baudry 1987). Mexico's production costs were from the Embassy of Mexico. Production costs for the EC, Australia, and Argentina were based on a country average (Table 5, Ortman et al. 1989). Production costs for Eastern Europe were assumed to be equal to Germany's production cost (Table 5).

Yields were collected by wheat class for each country and were a three-year simple or weighted average for 1986, 1987, and 1989. Yields for 1988 were not used because of drought conditions. The U.S yields for each production region were a weighted average of yields for crop reporting districts within the production region (Table 6, National Agricultural Statistics Service). Canada's yields for each production region were also a weighted average, calculated by multiplying the percent of acres harvested by yield and summing this amount for each crop reporting district within the production region (Table 7, Statistics Canada). Yields for Argentina, Eastern Europe, and the EC countries were a three-year country average for the same period (Table 7, International Wheat Council). Yields for these countries were not a weighted average because each country had one production region. Australia was divided into two production regions, east and west, and yields were calculated as a three-year weighted average for each production region using acres harvested and yields by state (Table 7, Australian Wheat Board).

Marketing Costs

Transportation costs were divided into two parts: inland transportation by rail, and ocean transportation. Transportation costs from production regions to both utilization centers and ports for all countries, were estimated using a linear function of rail mileage from selected sample routes.

TABLE 5. PRODUCTION COST BY PRODUCTION REGION FOR THE UNITED STATES, CANADA, MEXICO, THE EuropeAN COMMUNITY, EASTERN Europe, AUSTRALIA, AND ARGENTINA

Country and Production Region	Cost / Acre	Country and Production Region	Cost / Acre
	$ / Acre		$ / Acre
United States		Canada	
WA-1	118.65	AB-38	72.38
CA-2	183.74	AB-39	72.38
CA-3	189.48	SK-40	66.88
ID-4	185.04	SK-41	66.88
MT-5	80.29	SK-42	66.88
MT-6	80.29	MB-43	85.51
MT-7	80.29	MB-44	85.51
ND-8	74.47		
ND-9	74.47	Mexico	
ND-10	74.47	MX-45	350.00
ND-11	74.47	MX-46	350.00
ND-12	74.47	MX-47	350.00
SD-13	73.06	MX-48	350.00
SD-14	73.06	MX-49	350.00
SD-15	73.06		
NE-16	77.22	European Community	
NE-17	77.22	France-50	310.90
NE-18	77.22	Germany-51	363.87
CO-19	60.50	United Kingdom-52	314.28
KS-20	91.38		
KS-21	91.38	Eastern Europe	
KS-22	91.38	E. Europe-53	363.87
KS-23	91.38		
KS-24	91.38	Australia	
OK-25	73.24	W. Australia-54	57.04
OK-26	73.24	E. Australia-55	57.04
TX-27	90.03		
TX-28	90.03	Argentina	
MN-29	98.50	Argentina-56	49.54
MN-30	98.50		
IL--31	105.69		
TN-32	93.11		
IN-33	104.28		
OH-34	117.07		
GA-35	101.65		
NC-36	112.94		
DE-37	183.19		

TABLE 6. YIELD BY PRODUCTION REGION AND CLASS OF WHEAT, UNITED STATES, AVERAGE 1986, 1987, AND 1989

Production Region	HRW	HRS	SRW	DURUM
	------------------Bushels Per Acre--------------------			
WA-1	56.0	0.0	56.0	0.0
CA-2	76.0	0.0	0.0	0.0
CA-3	0.0	0.0	0.0	87.0
ID-4	68.6	0.0	72.3	0.0
MT-5	27.3	29.9	0.0	28.2
MT-6	37.4	35.2	0.0	39.0
MT-7	36.3	22.7	0.0	23.6
ND-8	0.0	25.1	0.0	28.0
ND-9	0.0	24.9	0.0	29.7
ND-10	0.0	36.0	0.0	35.4
ND-11	0.0	20.5	0.0	24.6
ND-12	0.0	27.5	0.0	29.4
SD-13	30.6	20.0	0.0	22.6
SD-14	29.2	25.7	0.0	29.9
SD-15	31.4	23.5	0.0	28.1
NE-16	37.9	0.0	0.0	0.0
NE-17	34.4	0.0	0.0	0.0
NE-18	33.5	0.0	0.0	0.0
CO-19	31.8	0.0	0.0	0.0
KS-20	33.5	0.0	0.0	0.0
KS-21	28.9	0.0	0.0	0.0
KS-22	29.6	0.0	0.0	0.0
KS-23	34.3	0.0	0.0	0.0
KS-24	28.1	0.0	0.0	0.0
OK-25	28.4	0.0	0.0	0.0
OK-26	26.4	0.0	0.0	0.0
TX-27	25.4	0.0	0.0	0.0
TX-28	23.3	0.0	0.0	0.0
MN-29	0.0	40.1	0.0	39.0
MN-30	0.0	36.4	0.0	39.0
IL--31	0.0	0.0	47.7	0.0
TN-32	0.0	0.0	37.8	0.0
IN-33	0.0	0.0	53.3	0.0
OH-34	0.0	0.0	50.7	0.0
GA-35	0.0	0.0	32.0	0.0
NC-36	0.0	0.0	38.4	0.0
DE-37	0.0	0.0	43.1	0.0

TABLE 7. YIELD BY PRODUCTION REGION AND CLASS OF WHEAT FOR CANADA, MEXICO, THE EUROPEAN COMMUNITY, EASTERN EUROPE, AUSTRALIA, AND ARGENTINA, AVERAGE 1986, 1987, AND 1989

Country and Production Region	HRW	HRS	SRW	DURUM
	------------- Bushels Per Acre ----------			
Canada				
AB-38	0.0	34.2	0.0	33.6
AB-39	0.0	24.8	0.0	26.2
SK-40	0.0	25.4	0.0	25.3
SK-41	0.0	26.2	0.0	26.1
SK-42	0.0	25.8	0.0	28.3
MB-43	0.0	26.3	0.0	27.1
MB-44	0.0	31.9	0.0	32.8
Mexico				
MX-45	0.0	0.0	78.3	78.3
MX-46	0.0	0.0	69.5	69.5
MX-47	0.0	0.0	63.1	63.1
MX-48	0.0	0.0	83.5	83.5
MX-49	0.0	0.0	33.2	33.2
European Community				
France-50	0.0	0.0	96.8	66.3
Germany-51	0.0	0.0	93.8	0.0
United Kingdom-52	0.0	0.0	102.0	0.0
Eastern Europe				
E. Europe-53	0.0	0.0	68.6	0.0
Australia				
Western Australia-54	20.4	0.0	0.0	0.0
Eastern Australia-55	23.8	0.0	0.0	0.0
Argentina				
Argentina-56	27.1	0.0	27.1	0.0

Equation 8 represents the rail rate function between U.S. production regions and both U.S. utilization centers and ports. This function was also used to estimate transportation costs between U.S. production regions and both Canadian and Mexican utilization centers.

Equation 9 represents the rail rate function between Canadian production regions and both Canadian utilization centers and ports. This function was also used to estimate

$$R_{ij} = (0.0143) * D_{ij}^{\ 0.67743}) * 22 \quad (20.05)^4 \quad R^2 = 0.814 \quad (8)$$

$$R_{ij} = ((0.0568)*D_{ij}^{\ 0.493263}) * 22 \quad (21.74) \quad R^2 = 0.942 \quad (9)$$

transportation costs between Canadian production regions and both U.S. and Mexican utilization centers.

Equation 10 represents transportation rates between Mexican production regions and both Mexican and U.S. utilization centers. This equation is also used to estimate transportation rates between production regions and both utilization centers and ports for European countries, Australia, and Argentina.

$$R_{ij} = ((0.0341)*D_{ij}^{\ 0.508342}) * 22 \quad (16.74) \quad R^2 = 0.761 \quad (10)$$

where:

R_{ij} = rail rates per metric ton for wheat shipments between origin i and destination j

D_{ij} = distance between origin i and destination j

Ocean freight rates from export ports in exporting countries to importing countries were also calculated by multiplying the estimated ocean freight function by ocean mileage (Defense Mapping Agency). The ocean freight rate function was estimated from the selected sample routes as follows:

$$OR_{pn} = 14.67 + 0.00156\ (OD_{pn}) \quad (89.09) \quad R^2 = 0.53 \quad (11)$$

where:

OR_{pn} = ocean freight rate per metric ton for wheat between origin p and destination n,

OD_{pn} = ocean milage between origin p and destination n

Policy Variables

This study includes four policy variables: tariffs, domestic production subsidies, export subsidies, and credit and LTAs. Tariffs are included for trade among the United States, Canada, and Mexico. Domestic production subsidies and export subsidies are included for all countries in the study. The application of credit and LTAs to the model is discussed in the section on constraints. The application of the other policy variables is discussed in the following sections.

Tariffs

Tariffs among the United States, Canada, and Mexico apply to trade for all classes of wheat among the three countries. Mexico's import tariffs are the highest among the three countries, and tariffs between the United States and Canada are the lowest because of the U.S.-Canada Free Trade Agreement, which eliminates tariffs between the two countries over a ten-year period (Table 8). Tariffs among the three countries are applied to transportation activities among the three countries.

TABLE 8. TARIFFS PLACED ON WHEAT TRADE AMONG THE UNITED STATES, CANADA, AND MEXICO

	Exporting Country		
Importing Country	United States	Canada	Mexico
	$/MT		
United States	--	4.00	7.70
Canada	2.64	--	4.41
Mexico	12.00	12.00	--

SOURCE: International Trade Commission.

Import tariffs were not placed in importing countries because these tariffs are equal across exporting countries and therefore, would not affect trade flows. Tariffs among the United States, Canada, and Mexico were applied to transportation activities among the three countries.

Subsidies

Producer Subsidy Equivalents (PSEs) are divided into several categories of policy transfers to producers: income support, price intervention, input and marketing assistance, infrastructure support, and regional support (USDA). For this study the categories were aggregated according to whether they applied to domestic production of wheat or export activities. The domestic production subsidy was applied by reducing production costs and the export subsidy by reducing ocean transportation costs.

Import License

Mexico uses an import license to protect domestic producers of wheat. The import license was incorporated by taking a three-year average (1988-90) of Mexico's wheat imports which amounted to 583 metric tons. This amount was used as a constraint in the model to limit Mexico's imports of wheat.

Constraints

Total land available for wheat in each production region was assumed to be two standard deviations above mean harvested acres over a 10-year period (1982 to 1991). The standard deviation was calculated as a percent of average harvested acres for each country (Table 9). Wheat acreage varied most for Australia and Argentina over this period and least for Canada and the EC.

TABLE 9. TWO STANDARD DEVIATIONS OF AVERAGE HARVESTED ACRES FOR AUSTRALIA, ARGENTINA, CANADA, EUROPEAN COMMUNITY, EASTERN EUROPE, MEXICO, AND THE UNITED STATES

Country	Standard Deviation
	Percent
Australia	33.0
Argentina	34.0
Canada	9.0
European Community	4.0
Eastern Europe	7.0
Mexico	18.0
United States	23.0

Average harvested acres for each production region was then multiplied by the standard deviation for that particular country. Average harvested acres by production region for the United States were from the National Agricultural Statistics Service and from the Canadian Wheat Board for Canada (Table 10). Average harvested acres for production regions in all other countries were from the International Wheat Council (Table 10).

Canadian and U.S. demand for wheat at each utilization center was calculated by dividing mill capacity of each class of wheat by total mill capacity of that wheat class, and then multiplying that percentage by domestic utilization of each class. Domestic utilization for the United States was from Wheat Situation and Outlook 1991 (Table 11). Canada's domestic utilization was from Statistics Canada 1991 and Mexico's domestic utilization was from Mielke (Table 12). Domestic utilization for the EC, Argentina, and Australia was from the International Wheat Council (Table 12).

Milling capacity and location of hard and soft wheat mills in both the United States and Canada were taken from Milling Directory and Buyers Guide, 1990 (Appendix A). All mill centers were developed by calculating which location had the larger capacity and including surrounding mills into that capacity.

TABLE 10. HARVESTED WHEAT ACREAGE BY PRODUCTION REGION, UNITED STATES, CANADA, MEXICO, THE EUROPEAN COMMUNITY, EASTERN EUROPE, AUSTRALIA, AND ARGENTINA, AVERAGE 1986, 1987, 1989

Country and Production Region	Acreage	Country and Production Region	Acreage
	1,000 Acres		1,000 Acres
United States		Canada	
WA-1	2,560	AB-38	4,018
CA-2	532	AB-39	3,115
CA-3	135	SK-40	4,053
ID-4	790	SK-41	9,032
MT-5	1,748	SK-42	7,101
MT-6	1,001	MB-43	2,656
MT-7	2,213	MB-44	2,316
ND-8	2,928		
ND-9	1,983	Mexico	
ND-10	2,870	MX-45	187
ND-11	547	MX-46	610
ND-12	979	MX-47	375
SD-13	842	MX-48	511
SD-14	1,755	MX-49	101
SD-15	1133		
NE-16	701	European Community	
NE-17	888	France-50	12,709
NE-18	479	Germany-51	7,367
CO-19	2,533	United Kingdom-52	5,088
KS-20	2,321		
KS-21	2,394	Eastern Europe	
KS-22	1,001	E. Europe-53	7,289
KS-23	1,740		
KS-24	2,211	Australia	
OK-25	3,268	W. Australia-54	8,283
OK-26	1,965	E. Australia-55	13,929
TX-27	2,033		
TX-28	1,579	Argentina	
MN-29	1,589	Argentina-56	12,432
MN-30	973		
IL--31	2,535		
TN-32	2,102		
IN-33	727		
OH-34	1,600		
GA-35	907		
NC-36	730		
DE-37	461		

TABLE 11. ESTIMATED UTILIZATION OF WHEAT BY CLASS FOR UTILIZATION CENTERS IN THE UNITED STATES

Utilization Center	HW[1]	SRW	DURUM
	------------Million Bushels-----------		
Seattle, WA	0.00	6.44	0.00
Spokane, WA	0.00	2.07	0.00
Pendleton, OR	0.00	0.00	4.42
Los Angeles, CA	87.92	3.82	0.00
Great Falls, MT	14.76	0.00	2.94
Billings, MT	7.29	0.00	0.00
Ogden, UT	37.81	4.60	6.18
Tolleson, AZ	15.62	0.00	1.84
Denver, CO	28.26	0.00	0.00
Grand Forks, ND	16.36	0.00	9.57
Rapid City, SD	4.46	0.00	0.00
Omaha, NE	65.16	0.00	0.00
Wichita, KS	156.64	0.00	0.00
Saginaw, TX	65.54	0.00	0.00
Minneapolis, MN	164.00	0.00	15.45
Superior, WI	0.00	6.21	0.00
Chicago, IL	0.00	5.52	0.00
St. Louis, MO	0.00	32.84	5.00
Kansas City, MO	42.34	28.51	3.68
Chattanooga, TN	0.00	26.41	0.00
Baton Rouge, LA	0.00	5.29	4.42
Indianapolis, IN	0.00	12.28	0.00
Toledo, OH	6.25	31.04	0.00
Cleveland, OH	0.00	12.96	0.00
Macon, GA	6.10	4.14	6.51
Buffalo, NY	0.00	36.06	0.00
Albany, NY	0.00	21.20	1.36
Lititz, PA	3.57	18.05	0.00
Culpeper, VA	17.93	1.60	0.00
Charlotte, NC	0.00	18.34	0.00
Tampa Bay, FL	0.00	12.65	0.00

[1] Includes both HRW and HRS wheat.

Note: Utilization refers to food, feed, and seed use.

TABLE 12. ESTIMATED UTILIZATION OF WHEAT BY CLASS FOR UTILIZATION CENTERS IN CANADA, THE EUROPEAN COMMUNITY, EASTERN EUROPE, MEXICO, AUSTRALIA, AND ARGENTINA

Utilization Center	HW[1]	SRW	DURUM
	------------Million Bushels------------		
Canada			
Armstrong, B.C.	3.92	0.00	0.00
Calgary, AB	21.45	6.12	4.71
Saskatoon, SK	13.93	3.70	4.71
Winnipeg, MB	5.28	0.00	0.00
Toronto, ON	76.67	8.87	8.47
Montreal, PQ	47.12	7.37	8.63
European Community			
Paris, France	0.0	363.74	108.90
Bonn, Germany	0.0	496.63	0.00
London, England	0.0	421.12	0.00
Brussels, Belgium	269.4	0.19	4.13
Madrid, Spain	91.5	2.99	1.54
Rome, Italy	542.6	3.18	9.68
Eastern Europe			
Budapest, Hungary	0.0	403.48	0.00
Warsaw, Poland	0.0	26.37	2.67
Bucharest, Romania	2.7	2.54	0.54
Mexico			
Mexicali	0.30	2.42	0.30
Chihuahua	1.20	11.72	1.20
Monterrey	1.60	16.17	1.60
Mexico City	9.30	92.86	9.30
Australia			
Fremantle	14.38	0.00	0.00
Sydney	115.98	0.00	0.00
Argentina			
Buenos Aires	171.60	0.00	0.00

[1] Includes both HRW and HRS wheat.

Note: Utilization refers to food, feed, and seed use.

Each importing region's demand for a class of wheat was calculated by summing the different classes of wheat exported from the United States, Canada, Australia, Argentina, and the EC from 1988 to 1990. Import demand by country was summed according to importing regions, and a three-year simple average was calculated (Table 13).

TABLE 13. WHEAT IMPORTS FOR IMPORTING REGIONS BY CLASS OF WHEAT

Import Region	HRW	HRS	SRW	DURUM
	----------1,000 Metric Tons-----------			
Northeast Africa	1,807.1	24.6	3,797.5	211.8
Northwest Africa	685.2	324.9	2,057.3	2,073.1
China	3,784.2	3,643.9	5,030.2	32.5
South Asia	1,013.0	510.7	2,829.5	0.0
Southeast Asia	1,898.0	1,709.9	628.4	0.0
West Asia	5,960.0	1,577.2	2,183.8	153.8
East Asia	3,360.4	3,081.8	2,256.2	208.1
Former Soviet Union	3,697.0	4,076.8	3,838.2	1,093.6
Western Europe	27.9	101.5	72.9	22.5
Western S. America	1,386.2	415.0	108.7	10.3
Northern S. America	173.0	622.0	63.3	232.8
Eastern S. America	1,440.8	216.3	20.9	0.0

SOURCE: Compiled from FAS, "U.S. Export Sales," the Canadian Wheat Board, the Australian Wheat Board, Eurostat, and the International Wheat Council.

Trade flows are influenced by credit and LTAs, which set a fixed amount of wheat to be traded over a specified period. This fixed amount was calculated by importing region for each exporting country and implemented into the model by using constraints on the amount of trade between exporting and importing countries with credit and LTAs (Table 14). The amount of wheat traded under credit obligations was an average taken from Foreign Ag. Service for 1987 to 1989. Wheat traded under LTAs came from the International Wheat Council and represents LTAs in force during 1991.

Results

Model 1, which includes domestic production, export subsidies and tariffs among the United States, Canada, and Mexico, replicates the current wheat market. The optimal solution of the base model is used to discuss changes in international trade flows.

TABLE 14. WHEAT IMPORTS FOR IMPORTING REGIONS UNDER CREDIT AND LONG-TERM AGREEMENTS, BY EXPORTING COUNTRY

Import Region	U.S.	Canada	EC	Argentina	Australia
	-------------1,000 Metric Tons-------------				
Northeast Africa	2,588	0	217	0	1,500
Northwest Africa	2,023	565	1,157	0	0
China	0	0	0	300	0
South Asia	698	35	0	0	0
Southeast Asia	0	0	0	0	0
West Asia	1,221	535	183	550	160
East Asia	0	1,200	0	0	900
Former Soviet Union	0	1,149	0	0	0
Western Europe	0	0	0	0	0
Western S. America	590	0	0	0	0
Northern S. America	113	0	0	0	0
Eastern S. America	67	215	0	1,450	0

SOURCE: Credit imports from Foreign Ag Service. Long-term agreement imports from International Wheat Council.

Results of this study are presented in three parts: First, a discussion of wheat production (acreage) is presented for the base and alternative models. Second, the distribution of wheat from exporting country to importing regions is presented for the base and alternative models. Third, the competitiveness of producing each class of wheat is analyzed, using weighted shadow prices.

Optimal Wheat Acreage

Model 1 evaluates competition among exporting countries based on production costs, marketing costs, domestic and export subsidies, tariffs among the United States, Mexico, and Canada, and Mexico's import license. The optimal total wheat acreage by country is presented in Table 15 and wheat acreage by class in Table 16. Comparing actual wheat acreage with that for Model 1 shows the United States is the only country with more wheat acreage than actual, indicating the United States should produce more wheat under given resource endowments and subsidy programs.

The comparison between actual and Model 1 wheat acreages by country are not compared to validate the model. Both acreage and

TABLE 15. OPTIMAL WHEAT ACREAGE BY COUNTRY FOR ALTERNATIVE MODELS

Country	Actual	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
	--------	--------	--------	--Million Acres--	--------	--------	--------	--------
U.S.	56.75	66.27	46.62	66.61	64.91	66.64	67.14	61.61
Canada	32.29	27.20	24.06	27.20	26.66	26.62	27.59	27.24
Mexico	1.79	1.83	1.83	1.83	1.83	1.83	0.42	0.92
EC	25.16	21.61	24.10	21,632	18.08	17.54	22.58	18.86
E. Europe	7.29	3.65	3.65	3.65	3.65	3.65	3.65	3.65
Australia	22.21	11.11	20.90	11.11	18.40	18.42	11.11	29.76
Argentina	12.43	8.93	16.65	8.47	16.66	16.66	8.93	16.66

TABLE 16. OPTIMAL WHEAT ACREAGE BY CLASS OF WHEAT AND COUNTRY FOR ALTERNATIVE MODELS[1]

Country and Class	Actual[2]	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
	--------	--------	--------	--------	--1,000 Acres--	--------	--------	--------
Soft Red Winter								
United States	11,940	14,812	9,695	14,812	15,143	15,143	14,812	14,230
EC	24,164	19,536	22,182	19,539	16,155	15,614	20,497	17,217
Argentina	--	13	0	0	11,559	13,493	13	10,924
E. Europe	7,289	3,645	3,645	3,645	3,645	3,645	3,645	3,645
Mexico	1,610	1,661	1,640	1,661	1,661	1,661	396	897
Hard Red Winter								
United States	27,650	36,713	24,495	37,185	34,632	36,356	37,684	33,777
Argentina	12,430	8,920	16,646	8,468	5,100	3,166	8,920	5,735
Australia	22,210	11,107	20,896	11,107	18,397	18,418	11,107	29,764
Hard Red Spring								
United States	13,930	9,441	6,671	9,061	9,607	9,363	9,243	7,605
Canada	26,820	25,190	22,688	25,553	24,503	24,744	25,348	24,920
Durum								
United States	3,230	5,308	5,760	5,552	5,532	5,776	5,402	5,993
Canada	5,470	2,005	1,375	1,643	2,144	1,875	2,244	2,317
EC	1,000	2,071	1,922	2,093	1,922	1,922	2,082	1,643
Mexico	180	169	165	169	169	169	25	25

[1]Model 1 is the base model;
Model 2 eliminates production subsidies;
Model 3 eliminates credit sales and Long-term agreements;
Model 4 eliminates export subsidies;
Model 5 eliminates all export promotion programs;
Model 6 eliminates trade restrictions in the North American market;
Model 7 complete world free trade in wheat.

[2]Adapted from Table 2.

export differences between actual and Model 1 are because of political as well as other influences on production and trade volume which cannot be captured in the model.

Base Model

The EC is the leading SRW producer followed by the United States. Both Mexico and Eastern Europe produce enough wheat to meet domestic utilization. The United States produces more SRW than actual and the EC less.

The U.S. HRW acreage is 33 percent more than actual in Model 1, primarily because Australia and Argentina, the two competitors in the HRW market, have relatively small domestic and export subsidy levels. Argentinean acreage is 75 percent and Australian acreage 50 percent of actual (Table 15). The U.S. and EC durum

The U.S. and EC durum acreages are more than actual, while Canada's acreage is half of actual because subsidy levels are higher in the United States and the EC relative to Canada. Although production practices in the United States and Canada are similar, marketing systems differ: Canadian wheat board vs. the U.S. private selling system. The difference in marketing systems was not captured in this model; thus, this may contribute in part to the difference in actual vs. Model 1 durum acreage.

HRS acreage is less than actual for both the United States and Canada. HRS and HRW are substitutable in domestic utilization in the United States and Canada. Production cost per bushel is lower for U.S. HRW relative to both U.S. and Canadian HRS. This may partially account for lower HRS acreage in the United States and Canada than actual and for greater U.S. HRW acreage than actual.

Removal of Domestic Production Subsidies

The impact of removing domestic subsidies is simulated in Model 2. Wheat acreage decreases 30 percent in the United States and 10 percent in Canada and doubles in Australia and Argentina. Wheat acreage in the EC increases 10 percent because of an increase in SRW acreage. U.S. domestic production subsidies are higher than EC or Canadian production subsidies.

A 37 percent decline in HRW acreage reduces U.S. acreage. Eliminating domestic subsidies reduces the U.S. competitive advantage over Australia and Argentina. Both Australia and Argentina have lower per bushel production costs without subsidies. Durum acreage in Canada and the EC decreases while U.S. acreage of durum increases. This indicates the United States has a competitive advantage in producing durum because of lower production costs.

HRS acreage in the United States and Canada decreases. U.S. domestic use of HRW increases because of lower per bushel production costs relative to HRS. The demand for HRS in the United States is reduced, which contributes to lower HRS acreage. The U.S. increases exports of HRS to Canada (relative to Model 1) which reduces Canadian acreage of HRS.

Removal of Credit and LTAs

Acreage decreases in the EC and Argentina, increases in the United States and Canada, and did not change in the other countries. Canada's HRS acreage increases, and U.S. HRS acreage decreases. U.S. HRW acreage increases and Argentinean HRW acreage decreases. U.S. acreage of durum increased and Canadian and EC durum acreage decreases. Although U.S. SRW acreage did not change EC SRW acreage increases and Argentinean SRW acreage was zero. These programs could allow an exporting country to export into a market that another country could supply at a lower cost. For example, Argentina can export HRW into West Asia and China under credit and LTAs; however, without these programs, the United States has a competitive advantage in exporting into those markets. In summary, credit and LTAs benefit U.S. HRS, Argentinean HRW and SRW, and Canadian and EC durum.

Removal of Export Subsidies

Eliminating export subsidies increases acreage in Argentina and Australia. Acreage decreases less than five percent in Canada and the United States and by 17 percent in the EC. This is primarily because the EC's export subsidies are higher than both U.S. and Canadian export subsidies. Argentina and Australia increase acreage because their export subsidies are lower than those in the United States, Canada, and the EC. Argentina also has an advantage over the EC in exporting SRW without export subsidies. U.S. and Canadian wheat acreage remain the same because of low production costs. The EC cannot compete without export subsidies to offset its high production costs.

SRW acreage decreases for the EC and increases for both the United States and Argentina[1]. Both Argentina and the United States have lower SRW production costs than the EC.

HRW acreage in Australia increases and decreases in the United States. Australia has lower per bushel production costs than the United States and also has a transportation advantage to major HRW markets, such as China and other Asian countries. HRW acreage decreases in Argentina because it produces SRW, given the removal of the EC's export subsidies.

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[1]Argentina's wheat has characteristics of both hard and soft wheat and therefore could be exported to EC soft wheat import markets under trade reform.

Durum acreage decreases in the EC but increases in the United States and Canada because of lower production costs in these two countries. Both U.S. and Canadian HRS acreage decreased.

Australia and Argentina would gain the most from the removal of export subsidies through increased HRW and SRW production and exports. The EC would lose the most through decreased production and exports of SRW and durum. Reduced export subsidies would not affect the United States and Canada. U.S. acreage of HRS and HRW would decrease while durum and SRW acreage would increase. Canada's acreage of durum would increase and acreage of HRS would decrease.

Removal of All Export Promotion Programs

Eliminating all export promotion policies (export subsidies, credit, and LTAs) doubles acreage in Australia and Argentina while U.S. acreage increases less than one percent. EC acreage decreases 20 percent and Canadian acreage two percent.

SRW acreage increases in the United States and Argentina, and decreases in the EC. Durum acreage decreases in the EC and increases in the United States and Canada. HRW acreage increases in Australia, remains the same in the United States, and decreases in Argentina. HRS acreage decreases less than five percent in the United States and Canada.

Eliminating all export promotion policies could benefit (in terms of increased acreage) Argentinean and U.S. SRW production, U.S. durum production, and HRW production in Australia. Eliminating these export policies would reduce EC in SRW and durum production, but may have no impact on U.S. HRS and HRW production and Canadian HRS production.

NAFTA Scenario

Model 6 eliminates trade barriers among the United States, Canada, and Mexico under the proposed NAFTA. Trade barriers include tariffs among the three countries and Mexico's import license. Acreage increases in the United States and Canada, but decreases in Mexico. U.S. acreage of HRW increases as does U.S. and Canadian acreage of durum. Mexico's SRW and durum acreage decreases, indicating Mexico is at a competitive disadvantage in producing wheat because of higher production costs relative to the United States and Canada.

World Free Trade

The elimination of all trade barriers, domestic subsidies, and export promotion policies decreases U.S. and EC acreage significantly, slightly increases Canada's acreage, and significantly increases acreage for Australia and Argentina. Mexico's acreage also decreases by 50 percent. This indicates Australia and Argentina are major beneficiaries under world free trade of wheat.

HRW acreage decreases in the United States and triples in Australia. Thus under free trade Australia has a competitive advantage over the United States in producing HRW. Australia has lower production costs and transportation costs to major HRW import markets. Argentina's HRW acreage decreases as it increases acreage for SRW. EC SRW acreage decreases 12 percent, and U.S. acreage of SRW remains unchanged. This indicates the United States and Argentina have a competitive advantage over the EC in producing SRW. Mexico's SRW acreage also decreases, indicating it has a competitive disadvantage in producing SRW.

U.S. acreage of HRS decreases while Canadian HRS acreage is nearly the same as Model 1. U.S. and Canadian acreage of durum increases while durum acreage for the EC decreases 21 percent. This indicates the U.S. and Canada have a competitive advantage over the EC. Also, the increased U.S. acreage of durum and decreased U.S. HRS acreage indicates durum may have a competitive advantage over HRS within the United States.

Optimal Wheat Exports

Base Model

The United States and EC export the most wheat for Model 1, followed by Canada, Argentina, and Australia (Table 17). Eastern Europe and Mexico do not export any wheat in Model 1. Comparing export levels for Model 1 with actual exports indicates U.S. and Canadian exports for Model 1 are higher, the EC's about the same, and Argentina and Australia exports substantially lower.

U.S. exports of SRW and HRS are less than actual, and exports of HRW and durum are more than actual (Appendix C). Canada's exports of HRS are more than actual, and exports of durum are less than actual. The EC's exports of SRW are more than actual and exports of durum are less than actual. Australia and Argentina's exports of HRW are less than actual.

In Model 1, the EC is the leading exporter of SRW followed by the United States and Argentina. The United States has an advantage in exporting SRW to Northeast (NE) Africa, East Asia, and South America over the EC, and the EC has an advantage over the United States in exporting SRW to the rest of Asia and Eastern Europe (Appendix Table C3). The United States and EC each exports SRW to Northwest (NW) Africa, China, and the FSU.

TABLE 17. OPTIMAL WHEAT EXPORTS FROM EXPORTING COUNTRIES TO IMPORTING REGIONS, MODEL 1

Import Region	United States	Canada	EC	Australia	Argentina
	1,000 Metric Tons				
NE Africa	4,124	0	217	1,500	0
NW Africa	3,419	565	1,157	0	0
China	5,092	3,644	2,997	457	300
S. Asia	698	511	2,830	0	315
SE Asia	0	1,710	628	252	1,646
W. Asia	5,849	1,057	2,260	160	550
E. Asia	4,925	3,082	0	900	0
FSU	7,377	3,410	1,919	0	0
W. Europe	130	0	95	0	0
W. S. America	1,505	415	0	0	0
N. S. America	236	686	169	0	0
E. S. America	67	215	0	0	1,450
EC	635	269	--	0	0
E. Europe	3	0	5,061	0	0
U.S.	--	120	--	--	--
Canada	711	--	--	--	--
Mexico	354	0	0	0	0
Total	35,125.00	15,684.00	17,333.00	3,269.00	4,261.00

The United States is the leading exporter of HRW, followed by Argentina and Australia. The United States is the primary exporter of HRW to NW Africa, China, all of Asia, except Southeast (SE) Asia, the FSU, Western Europe, Western and Northern South America, and Mexico. Australia is the primary exporter to NE Africa and Argentina to SE Asia and Eastern South (ES) America (Appendix Table C).

The U.S. exports HRS to NE Africa, West Asia, the FSU, Western Europe, E.S. America, the EC, and Eastern Europe. However, the U.S. is only the primary exporter to NE Africa, Western Europe, and the EC. Canada is the primary exporter to the remaining HRS markets.

The United States is the primary exporter to all durum import markets except Northern South (NS) America and Eastern Europe which the E.C. served. Canada competes with the United States in the NW Africa and FSU markets.

Removal of Domestic Production Subsidies

U.S. exports decrease by 50 percent, Australian and Argentinean exports increase by more than three times, Canadian exports decrease by 6 percent, and EC exports increase by 38 percent (Table 18). Mexican and Eastern European exports do not change. EC exports increase because the EC has lower production subsidies than the United States. The EC emphasizes export subsidies rather than subsidies on domestic production.

TABLE 18. OPTIMAL WHEAT EXPORTS FROM EXPORTING COUNTRIES TO IMPORTING REGIONS, MODEL 2

Import Region	United States	Canada	EC	Australia	Argentina
	--------------------1,000 Metric Tons			---------------------	
NE Africa	2,588	0	1,753	1,500	0
NW Africa	2,518	565	2,057	0	0
China	33	3,644	5,030	3,484	300
S. Asia	698	511	2,830	315	0
SE Asia	0	1,710	628	1,898	0
W. Asia	701	1,057	2,184	160	5,776
E. Asia	1,313	3,082	2,256	2,256	0
FSU	6,325	2,613	1,919	0	1,849
W. Europe	152	0	73	0	0
W. S. America	1,397	415	109	0	0
N. S. America	113	855	63	0	60
E. S. America	67	215	0	0	1,450
EC	362	0	--	0	543
E. Europe	3	0	5,061	0	0
U.S.	--	120	--	--	--
Canada	946	--	--	--	--
Mexico	354	0	0	0	0
Total	17,570.00	14,787.00	23,963.00	9,613.00	9,978.00

A 64 percent decrease caused most of the decrease in U.S. exports (Appendix D). The United States has higher per bushel production costs for HRW than Australia and Argentina. U.S. exports of HRW decrease to China, West Asia, East Asia, and the FSU. Australia increases exports of HRW to China and East Asia while Argentina's exports increase to West Asia and the FSU. Overall, Argentina was the leader in HRW exports, followed closely by Australia and the United States.

U.S. SRW exports also decrease, but EC exports of SRW increase. EC SRW exports increasd to NE and NW Africa, China, East Asia, and Western South America, all at the expense of U.S. exports to these markets. U.S. SRW exports to Mexico increase because removing domestic subsidies reduced Mexico's competitiveness relative to the United States. U.S. production costs for SRW are lower than Mexico's production costs for SRW.

U.S. HRS exports increase to the FSU, the EC, and Canada, although Canada remains the leading exporter of HRS. Canada's major HRS markets include the Asian regions, China, and South America. This indicates domestic production subsidies benefit Canadian HRS more than U.S. HRS.

Eliminating domestic subsidies increase U.S. durum exports to West Asia, the FSU and Western Europe. Although Canada's and the EC's exports of durum decrease, Canada replaced the EC as the primary source of durum to Northern South America. Canada and the EC benefit more than the United States from domestic production subsidies on durum.

Removal of Credit Sales and LTA's

Exports of the United States, the EC, and Argentina decrease while Canadian exports increase, and Australian exports are unchanged (Table 19).

Canada's exports of HRS increase while U.S. exports of HRS decrease (Appendix E). Canada's HRS exports increase to the FSU and West Europe and decrease to NW Africa, West Asia and Eastern South America. This indicates credit and LTA's are important for Canada in maintaining markets in NW Africa, West Asia and Eastern South America.

EC and Canadian exports of durum decrease while U.S. exports of durum increase. U.S. exports of durum increase to NW Africa and Canadian exports increase to Northern South America thereby reducing EC durum exports to this market. This indicates credit and LTA's are important for Canada in the NW African market and for the EC in Northern South America.

HRW exports of the United States increase, while those of Australia are unchanged, and Argentina's decrease. The United States replaces Australia as the major exporter of HRW to NE Africa and Australia replaced the United States as the primary supplier of HRW to China. Argentina is the primary source of HRW to South Asia. U.S. exports to both West and East Asia increase at the expense of Australia and Argentina.

U.S. exports of SRW are unchanged, EC exports of SRW increase, and Argentina's exports of SRW decrease. SRW exports were reallocated among import markets with little or no change in total export volume. U.S. exports increase to NW Africa while EC exports increase to NE Africa and Eastern South America.

TABLE 19. OPTIMAL WHEAT EXPORTS FROM EXPORTING COUNTRIES TO IMPORTING REGIONS, MODEL 3

Import Region	United States	Canada	EC	Australia	Argentina
	---------------------1,000 Metric Tons--------------------				
NE Africa	4,480	0	1,361	0	0
NW Africa	5,140	0	0	0	0
China	3,241	3,644	2,998	2,609	0
S. Asia	0	511	2,830	0	1,013
SE Asia	0	1,710	628	660	1,238
W. Asia	6,600	789	2,261	0	226
E. Asia	5,825	3,082	0	0	0
FSU	6,267	4,521	1,919	0	0
W. Europe	28	102	96	0	0
W. S. America	1,505	415	0	0	0
N. S. America	236	825	30	0	0
E. S. America	216	0	21	0	1,441
EC	92	812	--	0	0
E. Europe	3	0	5,061	0	0
U.S.	--	120	--	--	--
Canada	711	--	--	--	--
Mexico	354	0	0	0	0
Total	34,698.00	16,531.00	17,205.00	3,269.00	3,918.00

Removal of Export Subsidies

Both U.S. and EC exports decrease but exports by Canada, Australia, and Argentina increase (Table 20). EC exports decrease by over 60 percent while U.S. exports decrease four percent. Australian and Argentinean exports are more than doubled while Canadian exports increase two percent.

Exports of SRW increase for the United States and Argentina while EC exports of SRW decrease 53 percent (Appendix F). U.S. exports to NW Africa and China decrease while exports to West Asia, the FSU, and Western Europe increase. Argentina's exports to NW Africa, China, Asia, and Eastern South America increase. EC exports to China and Asia decrease because of increased Argentinean exports to these regions, and EC exports to the FSU decrease because of increased U.S. SRW exports to this region.

U.S. exports of HRW decrease as do Argentina's exports of HRW. Australia's exports of HRW increase relative to Model 1. Eliminating export subsides benefits Australia, which increases exports of HRW to China at the expense of U.S. and Argentinean exports to South and SE Asia at the expense of Argentina. Argentina's exports of HRW decrease because it is more competitive in shipping its wheat to the SRW import markets of

TABLE 20. OPTIMAL EXPORTS FROM MAJOR EXPORTING COUNTRIES TO IMPORTING REGIONS, MODEL 4

Import Region	United States	Canada	EC	Australia	Argentina
	---------------------1,000 Metric Tons---------------------				
NE Africa	4,683	0	217	1,500	0
NW Africa	2,300	565	1,157	0	560
China	2,401	3,644	0	3,218	3,229
S. Asia	698	511	0	315	2,830
SE Asia	0	1,710	0	1,898	628
W. Asia	7,200	1,057	184	160	1,275
E. Asia	4,925	3,082	0	900	0
FSU	8,096	3,087	1,523	0	0
W. Europe	123	102	0	0	0
W. S. America	1,505	415	0	0	0
N. S. America	236	855	0	0	0
E. S. America	67	215	0	0	1,450
EC	321	582	--	0	0
E. Europe	3	0	5,061	0	0
U.S.	--	120	--	--	--
Canada	711	--	--	--	--
Mexico	354	0	0	0	0
Total	33,623.00	15,945.00	8,142.00	7,991.00	9,972.00

the EC than to HRW import markets. U.S. exports of HRW to West Asia and Eastern South America increase.

The United States increases exports of HRS, and Canada's HRS exports decrease. U.S. exports to the FSU and the EC increase, reducing Canadian exports to these import markets. Canada remains the major exporter of HRS.

Both the United States and Canada increase exports of durum, while EC exports of durum decrease. U.S. exports increase to West Asia and Western Europe at the expense of the EC. U.S. exports also increase to the FSU, which decrease Canadian exports to this region. Canadian exports to Northern South America increase, eliminating EC exports to this region.

Removal of all Export Promotion Policies

Canada, Australia, and Argentina all increase exports, while EC exports decrease 61 percent (Table 21). U.S. exports decreasd by less than one percent.

TABLE 21. OPTIMAL WHEAT EXPORTS FROM EXPORTING COUNTRIES TO IMPORTING REGIONS, MODEL 5

Import Region	United States	Canada	EC	Australia	Argentina
	---------------------1,000 Metric Tons---------------------				
NE Africa	3,937	0	0	0	1,789
NW Africa	5,140	0	0	0	0
China	1,835	3,644	0	3,784	3,229
S. Asia	0	511	0	1,013	2,830
SE Asia	0	1,710	0	1,898	628
W. Asia	7,995	789	0	0	1,092
E. Asia	4,505	3,082	0	1,319	0
FSU	6,808	3,980	1,651	0	268
W. Europe	226	0	0	0	0
W. S. America	1,505	415	0	0	0
N. S. America	236	855	0	0	0
E. S. America	1,657	0	0	0	21
EC	92	812	--	0	0
E. Europe	3	0	5,061	0	0
U.S.	--	120	--	--	--
Canada	711	--	--	--	--
Mexico	354	0	0	0	0
Total	35,004.00	15,918.00	6,712.00	8,014.00	9,857.00

The major change in exports occurs for SRW where EC exports decrease 61 percent (Appendix G). U.S. and Argentinean exports of SRW increase. U.S. SRW exports increase to NW Africa, West Asia, and Western Europe, eliminating EC exports to these markets and NE Africa, China, South Asia, SE Asia, and the FSU because Argentina increase SRW exports to these markets.

U.S. exports of HRW increase one percent, Argentina's exports of HRW decrease to zero, and Australia's exports of HRW increase by one and a half times. U.S. HRW exports to NE Africa, West Asia, and Eastern South America increase. Australia increases exports to China, South Asia, and SE Asia. Argentina did not export any HRW because it was more competitive in exporting SRW to import markets supplied by the EC in the base model.

U.S. exports of HRS increase eight percent while Canadian HRS exports decrease one percent. U.S. exports to NW Africa, West Asia, and Eastern South America increase while shipments to the FSU decrease. Overall, Canada is the major exporter of HRS.

EC durum exports decrease 75 percent, U.S. durum exports increase 12 percent, and Canadian durum exports decrease 15 percent. U.S. exports to NW Africa and the FSU increase, eliminating Canadian exports to these import markets. U.S. exports also increase to West Asia and Western Europe eliminating EC exports to these markets. Canada increases exports to Northern South America, eliminating EC exports to that market.

NAFTA Scenario

Canada's exports increase six percent under NAFTA, and the EC's exports increase 15 percent (Table 22). U.S. exports decrease less than one percent and Australian and Argentinean exports do not change.

TABLE 22. OPTIMAL WHEAT EXPORTS FROM EXPORTING COUNTRIES TO IMPORTING REGIONS, MODEL 6

Import Region	United States	Canada	EC	Australia	Argentina
	---------------------1,000 Metric Tons---------------------				
NE Africa	2,588	0	1,753	1,500	0
NW Africa	2,518	565	2,057	0	0
China	5,126	3,644	2,963	457	300
S. Asia	698	511	2,830	0	315
SE Asia	0	1,710	628	252	1,646
W. Asia	5,849	1,057	1,092	160	550
E. Asia	4,925	3,082	1,169	900	0
FSU	7,627	3,160	1,919	0	0
W. Europe	28	102	95	0	0
W. S. America	1,424	415	82	0	0
N. S. America	173	676	242	0	0
E. S. America	67	215	0	0	1,450
EC	107	797	--	0	0
E. Europe	3	0	5,061	0	0
U.S.	--	522	--	--	--
Canada	711	--	--	--	--
Mexico	3,052	195	0	0	0
Total	34,896.00	16,651.00	19,891.00	3,269.00	4,261.00

Exports of SRW decrease for the United States and increase for the EC (Appendix H). U.S. exports to NE Africa, NW Africa, Western South America, and Northern South America decrease while

EC exports increase to those markets. U.S. SRW exports decrease primarily because free trade increase U.S. exports of SRW to Mexico from zero to 2.57 million metric tons.

HRW exports for the United States, Argentina, and Australia do not change. Both U.S. and Canadian HRS exports increase. U.S. exports of HRS to the FSU and the EC increase reducing Canadian exports to these markets. However, overall Canadian exports of HRS increase because Canadian HRS exports increase to the United States (Appendix Table H2).

U.S. and Canadian exports of durum to Western South America and Northern South America decrease while EC durum exports increase to these markets. Both U.S. and Canadian exports of durum increase to Mexico under free trade (Appendix Table H4).

World Free Trade

The result of world free trade is a 24 percent decrease in U.S. exports, a 5 percent increase in Canadian exports, and a 38 percent decrease in EC exports (Table 23). Both Australian and Argentinean exports increase substantially.

U.S. SRW exports decrease four percent, EC SRW exports decrease 38 percent, and Argentinean SRW exports increase substantially (Appendix I). U.S. exports to NW Africa and Mexico increase while shipments decrease to NE Africa, China, and Eastern South America. EC exports increase to NE Africa, and Argentinean exports increase to China and the Asian markets, formerly supplied by the EC.

U.S. exports of HRW decrease 50 percent and Argentinean HRW exports decrease 55 percent. Australia increases exports of HRW three and a half times. U.S. exports of HRW increase to NE Africa but decline to China, South Asia, West Asia, East Asia, and Northern South America. Australian exports increase to China and the Asian markets and decrease to NE Africa. Argentina's exports to China and the Asian markets decrease primarily because it is more competitive in exporting SRW to import markets formerly supplied by the EC.

The U.S. exports of HRS increase 24 percent, and Canadian exports of HRS remain about the same as Model 1. U.S. exports of HRS increase to NW Africa, West Asia, Eastern South America, and Canada. Canadian exports decrease to those same markets but increase to the United States. Canada has a trade surplus with the United States in HRS. Canada's exports also increase to the FSU under free trade, reducing U.S. exports.

EC exports of durum decrease to zero, and U.S. and Canadian exports increase 36 and 21 percent. U.S. exports of durum increase to NW Africa, West Asia, Western Europe, the EC, Eastern

TABLE 23. OPTIMAL EXPORTS FROM MAJOR EXPORTING COUNTRIES TO IMPORTING REGIONS, MODEL 7

Import Region	United States	Canada	EC	Australia	Argentina
	--------------------1,000 Metric Tons--------------------				
NE Africa	3,042	0	2,800	0	0
NW Africa	5,141	0	0	0	0
China	1,521	3,644	0	3,784	3,502
S. Asia	0	511	0	1,013	2,830
SE Asia	0	1,710	0	1,898	628
W. Asia	1,940	789	1,092	4,678	1,377
E. Asia	2,464	3,082	0	3,360	0
FSU	7,007	3,850	1,919	0	0
W. Europe	153	0	73	0	0
W. S. America	1,495	425	0	0	0
N. S. America	63	855	0	0	173
E. S. America	216	0	0	0	1,462
EC	511	812	--	0	0
E. Europe	91	0	4,973	0	0
U.S.	--	809	--	--	--
Canada	818	--	--	--	--
Mexico	2,125	0	0	0	0
Total	26,587.00	16,487.00	10,857.00	14,733.00	9,972.00

Europe, and Mexico. Canadian exports increase to the United States and to South American markets (Appendix Table I4). The EC exports no durum under complete free trade.

Regional and International Production Competitiveness

Competitiveness can be measured, using a weighted shadow price calculated from shadow prices generated for the upper limit of the land constraint. These shadow prices indicate the amount the objective function would decrease if an additional acre of land is put into production. Thus, the higher the weighted shadow price in absolute value, the more competitive the region is in producing additional wheat.

Production regions were combined into geographic regions, and the ratio of total acreage in each production region to the upper limit of acreage in each geographic region was used as the weight. This weight was multiplied by the corresponding shadow price to compute a weighted shadow price (Table 24). Weighted shadow prices were calculated for the base and world free trade model and compared to determine the impact of trade policies on competitiveness. Weighted shadow prices were compared regionally within a country and internationally.

Shadow prices represent a region's competitiveness in producing wheat relative to another region. These shadow prices do not account for other crops (i.e., vegetables and feed grains) which may be grown more competitively than wheat. A region such as California may have a high shadow price, indicating it should increase wheat production; however, this may not be feasible since it would take land away from more profitable enterprises, such as growing vegetables.

HRW

Shadow prices indicate Montana, Nebraska, South Dakota, and California are the most competitive HRW production regions in the United States for Model 1 (Table 24). These regions are more competitive than Colorado-Kansas and Oklahoma-Texas because they are closer to export ports. All HRW production regions in the United States are more competitive than Argentina and Australia. This is because domestic and export subsidies are higher for the United States than for Argentina and Australia.

Assuming complete free trade in Model 7 reduces the competitiveness of all HRW production regions in the United States except California. Both Argentina and Australia are competitive with U.S. HRW production regions under free trade.

SRW

Washington (which produces mostly white winter wheat) is the most competitive SRW production region in the United States, followed by Indiana-Ohio, Illinois-Tennessee, and Georgia-North and South Carolina. Washington and Indiana-Ohio are the most competitive regions because they are closest to export ports at Seattle and Cleveland. Idaho is the least competitive SRW production region in the United States because of relatively higher production costs than other SRW production regions.

Baja Calif (Mexico-45) and West Central Mexico (Mexico-47) are competitive for Model 1 because Mexico's import license protects producers from foreign competition. The only other competitive region outside the United States is the United Kingdom, which is the most competitive European SRW production region because of higher yields.

Free trade reduced competitiveness for all SRW production regions in the United States, except Idaho. Washington and Indiana-Ohio have the smallest decrease in competitiveness because these two production regions are near export ports.

TABLE 24. WEIGHTED SHADOW PRICES BY REGION FOR MODELS 1 AND 7

Region and Class of Wheat	Model 1	Model 7
WA (SRW)	86.02	78.31
ID (SRW)	19.05	29.15
IL-TN (SRW)	45.72	29.30
IN-OH (SRW)	62.73	56.38
GA-SC-NC (SRW)	30.75	5.20
DE (SRW)	0.00	0.00
EC-1 (SRW-D)	0.00	0.00
EC-2 (SRW)	0.00	0.00
EC-3 (SRW)	35.29	17.02
Eastern Europe (SRW)	0.00	0.00
Mexico-1 (SRW-D)	11.91	0.00
Mexico-2 (SRW)	0.00	0.00
Mexico-3 (SRW-D)	120.27	13.73
Argentina (HRW/SRW)[1]	0.00	37.32
Australia-1 (HRW)	0.00	13.17
Australia-2 (HRW)	0.00	17.35
SD (HRW)	25.98	16.16
NE (HRW)	25.99	22.45
CO-KS (HRW)	9.88	4.97
OK-TX (HRW)	9.74	2.50
CA (HRW-D)	24.17	69.68
MT (HRW-HRS)	27.18	11.59
ND (HRS-D)	14.38	12.68
MN (HRS)	10.17	19.43
Canada-AB (HRS-D)	4.23	12.18
Canada-SK (HRS-D)	0.85	1.50
Canada-MB (HRS-D)	0.00	0.00

[1]Argentina produces primarily HRW for Model 1 and primarily SRW for Model 7.

Free trade reduces competitiveness for Mexico and the United Kingdom. Argentina, which produce most of its wheat for the SRW market under free trade, increase its competitiveness. Washington and Indiana-Ohio are more competitive than Argentina in producing SRW, however, all other U.S. and European production regions are less competitive than Argentina.

HRS and Durum

Although Montana is the most competitive among production regions producing HRS it uses most of its acreage for HRW production. North Dakota, the major HRS production region is more competitive than Minnesota, primarily because of lower production costs per acre.

Alberta is more competitive than Saskatchewan in producing HRS and durum because it was closer to the export port at Vancouver. North Dakota is more competitive in producing HRS and durum than both Alberta and Saskatchewan, possibly because of higher subsidy levels in the United States relative to Canada.

Two of Mexico's production regions produce durum and are competitive; however, like California, these production regions produce only a small amount of durum. Free trade eliminates Mexico's import license reducing its competitiveness.

Free trade reduces competitiveness of HRS for both Montana and North Dakota but Minnesota's competitiveness increases. Minnesota is the most competitive region under free trade because it is near to the Duluth port. Free trade has the smallest impact on North Dakota indicating it could be competitive in producing HRS and durum under free trade. California's competitiveness increases substantially under free trade, primarily because of HRW, not durum production.

Alberta and Saskatchewan both increases their competitiveness for producing HRS and durum under free trade. Alberta is still the most competitive region in Canada because it's near the port at Vancouver. Alberta is more competitive than Montana but less competitive than North Dakota and Minnesota in producing HRS under free trade. North Dakota is more competitive than Alberta and Saskatchewan in producing durum.

Summary and Conclusions

A spatial programming model is used to evaluate international competition among the United States, Canada, Mexico, the European Community (EC), Eastern Europe, Argentina, and Australia in the production and export of wheat. The model divides wheat into four classes: soft-red winter (SRW), hard red winter (HRW), hard red spring (HRS), and durum. The model includes tariffs among the United States, Canada, and Mexico as well as Mexico's import license. The model also includes domestic production subsidies, export subsidies, and credit and long-term agreements exporting countries use. Six additional models are simulated to analyze the impacts of removing production and export subsidies, credit and long-term agreements, and the North American Free Trade Agreement on production and exports of wheat.

Eliminating production subsidies reduces U.S. production and exports of both HRW and SRW. Argentina and Australia would both increase production and exports of HRW. The EC would increase production and export of SRW. U.S. durum production and exports would increase while both Canada and the EC would reduce production and exports of durum. U.S. production and exports of HRS increase while Canadian production and exports of HRS decrease.

Removing credit and LTAs causes U.S., EC, and Argentinean exports to decrease while Canada's exports increase and Australia's remain unchanged. U.S. exports of HRS decline and Canadian HRS exports increase. U.S. SRW exports are unchanged but EC exports of SRW increase. Both EC and Canadian durum exports increase while U.S. exports of durum decline. U.S. HRW exports increase, Australia's remain unchanged and Argentina's decrease.

EC exports decrease 60 percent with the removal of export subsidies. U.S. exports decrease four percent, Canadian exports increase two percent, and both Argentinean and Australian exports double.

EC exports of SRW decrease 53 percent, and durum exports also decline. U.S. exports of HRS, SRW, and durum increase, nearly offsetting a large decline in U.S. HRW exports. Canada's exports of durum increase, and HRS exports decrease. Australia's exports of HRW increase and Argentina's exports into former SRW markets served by the EC increase substantially.

The NAFTA increases U.S. and Canadian exports of durum and HRS, mostly to Mexico. U.S. exports of SRW to Mexico increase, reducing the number of other import markets the United States can supply. This increases EC exports of SRW to import markets formerly served by the United States.

World free trade reduces both U.S. and EC exports and increase Canadian, Australian, and Argentinean exports. Both U.S. and Canadian durum exports increase; however, only U.S. HRS exports increase while Canada's remain unchanged. EC exports of both SRW and durum decrease with Argentina increasing exports into import markets formerly served by the EC. U.S. exports of SRW decrease. U.S. exports of HRW decrease the most, while Australia's exports of HRW increase three and a half times.

This study shows that trade policies affect each class of wheat differently in terms of production and exports. Eliminating subsidies had a negative impact on U.S. HRW production and EC durum and SRW production. The U.S. and Canadian durum industries benefit from lower EC production. Both Australia and Argentina have the largest gains in production, Australia by increasing exports to markets where the United States exports HRW with subsidies in place and Argentina by increasing exports to SRW markets formerly supplied by the EC.

The NAFTA benefits U.S. durum and SRW production and Canadian durum production. Both U.S. and Canadian durum exports to Mexico increase under NAFTA as do U.S. SRW exports to Mexico. Mexican SRW and durum production both decrease.

World free trade reduces the competitiveness of U.S. HRW and increases the competitiveness of HRW in Australia and Argentina. The increase in competitiveness for Argentina is primarily for wheat produced to export SRW into former EC SRW markets. This reduces the competitiveness of EC SRW. Free trade increases the competitive position of U.S. and Canadian durum production. This study shows that the closer a production region is to export ports, the more competitive the region. This indicates transportation costs are more important in determining competitiveness than production costs.

The study does have some limitations, which should be considered when interpreting its results. One limitation is the linear programming model used minimizes total production and marketing costs unlike quadratic programming models, which maximize social welfare. Therefore, from this study we cannot infer whether producers (or consumers) are better or worse off from changes in trade policies. The second limitation is the exclusion of processing costs mainly because of the unavailability of data. A final limitation is that the model does not allow commerical storage and stock at ports. Thus, optimal results cannot be interpreted in terms of absolute magnitude but rather in terms of order and changes in magnitude.

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APPENDIX A

APPENDIX TABLE A1: AVERAGE ACRES HARVESTED, YIELD, AND PRODUCTION COSTS FOR HARD RED WINTER WHEAT BY PRODUCING REGION

Reg. #	Distribution Center	Land (,000 acres)	Yield (bu/acre)	Production Costs ($/acre)
1	Yakima, WA	252	56.0	118.65
2	Sacramento, CA	532	76.0	183.74
4	Pocatello, ID	217	68.6	185.04
5	Havre, MT	483	27.3	80.29
6	Billings, MT	768	37.4	80.29
7	Wolf Point, MT	694	36.3	80.29
13	Rapid City, SD	610	30.6	73.06
14	Aberdeen, SD	274	29.2	73.06
15	Huron, SD	706	31.4	73.06
16	Alliance, NE	701	37.9	77.22
17	North Platte, NE	888	34.4	77.22
18	Lincoln, NE	479	33.5	77.22
19	Sterling, CO	2,533	31.8	60.50
20	Colby, KS	2,321	33.5	91.38
21	Salina, KS	2,394	28.9	91.38
22	Chanute, KS	1,001	29.6	91.38
23	Garden City, KS	1,740	34.3	91.38
24	Wichita, KS	2,211	28.1	91.38
25	Enid, OK	3,268	28.4	73.24
26	Oklahoma City, OK	1,965	26.4	73.24
27	Amarillo, TX	2,033	25.4	90.03
28	Abilene, TX	1,579	23.3	90.03

APPENDIX TABLE A2. AVERAGE ACRES HARVESTED, YIELD, AND PRODUCTION COSTS FOR HRS WHEAT BY PRODUCING REGION

Reg. #	Distribution Center	Land (,000 acres)	Yield (bu/acre)	Production Costs ($/acre)
5	Havre, MT	1,226	29.9	80.29
6	Billings, MT	230	35.2	80.29
7	Wolf Point, MT	1,310	22.7	80.29
8	Williston, ND	1,770	25.1	74.47
9	Rugby, ND	1,259	24.9	74.47
10	Grand Forks, ND	2,153	36.0	74.47
11	Bismarck, ND	522	20.5	74.47
12	Wahpeton, ND	879	27.5	74.47
13	Rapid City, SD	222	20.0	73.06
14	Aberdeen, SD	1,409	25.7	73.06
15	Huron, SD	419	23.5	73.06
29	Crookston, MN	1,565	40.1	98.50
30	Wilmar, MN	964	36.4	98.50
38	Lethbridge, ALB.	3,494	35.1	72.38
39	Medicine Hat, ALB.	2,823	27.4	72.38
40	Wilkie, SASK.	2,951	28.3	66.88
41	Assiniboia, SASK.	7,014	27.2	66.88
42	Yorkton, SASK.	5,934	28.2	66.88
43	Brandon, MAN.	2,390	28.6	85.51
44	Mordon, MAN.	2,215	32.4	85.51

APPENDIX TABLE A3. AVERAGE ACRES HARVESTED, YIELD, AND PRODUCTION COSTS FOR SRW BY PRODUCING REGION

Reg. #	Distribution Center	Land (,000 acres)	Yield (bu/acre)	Production Costs ($/acre)
1	Yakima, WA	2,308	56.0	118.65
2	Pocatello, ID	573	72.3	185.04
31	Cairo, IL	2,535	47.7	105.69
32	Memphis, TN	2,102	37.8	93.11
33	Fort Wayne, IN	727	53.3	104.28
34	Lima, OH	1,600	50.7	117.07
35	Macon, GA	907	32.0	101.65
36	Raleigh, NC	730	38.4	112.94
37	Wilmington, DE	461	43.1	183.19

APPENDIX TABLE A4. AVERAGE ACRES HARVESTED, YIELD, AND PRODUCTION COSTS FOR DURUM BY PRODUCING REGIONS

Reg. #	Distribution Center	Land (,000 acres)	Yield (bu/acre)	Production Costs ($/acre)
3	Niland, CA	135	87.0	189.48
5	Havre, MT	39	28.2	80.29
6	Billings, MT	3	39.0	80.29
7	Wolf Point, MT	209	23.6	80.29
8	Williston, ND	1,158	28.0	74.47
9	Rugby, ND	724	29.7	74.47
10	Grand Forks, ND	717	35.4	74.47
11	Bismarck, ND	25	24.6	74.47
12	Wahpeton, ND	100	29.4	74.47
13	Rapid City, SD	10	22.6	73.06
14	Aberdeen, SD	72	29.9	73.06
15	Huron, SD	8	28.1	73.06
29	Crookston, MN	24	39.0	98.50
30	Wilmar, MN	9	39.0	98.50
38	Lethbridge, ALB.	524	33.6	72.38
39	Medicine Hat, ALB.	292	26.2	72.38
40	Wilkie, SASK.	1,102	25.3	66.88
41	Assiniboia, SASK.	2,018	26.1	66.88
42	Yorkton, SASK.	1,167	28.3	66.88
43	Brandon, MAN.	266	27.1	85.51
44	Mordon, MAN.	101	32.8	85.51

APPENDIX B

APPENDIX TABLE B1. CAPACITIES OF DIFFERENT WHEAT CLASSES AT MILL CENTERS

MILL #	LOCATION	HWC	CAPACITY (CWT) SWC	DURUM
1	Seattle, WA		14,000	
2	Spokane, WA		4,500	
3	Pendleton, OR			6,000
4	Los Angeles, CA	59,100	8,300	
5	Great Falls, MT	9,920		4,000
6	Billings, MT	4,900		
7	Ogden, UT	25,420	10,000	8,400
8	Tolleson, AZ	10,500		2,500
9	Denver, CO	19,000		
10	Grand Forks, ND	11,000		13,000
11	Rapid City, SD	3,000		
12	Omaha, NE	43,800		
13	Wichita, KS	105,300		
14	Saginaw, TX	44,060		
15	Minneapolis, MN	110,250		21,000
16	Superior, WI		13,500	
17	Chicago, IL		12,000	
18	St. Louis, MO		71,400	6,800
19	Kansas City, MO	28,460	61,980	5,000
20	Chattanooga, TN		57,425	
21	Baton Rouge, LA		11,500	
22	Indianapolis, IN		26,700	
23	Toledo, OH	4,200	67,500	
24	Cleveland, OH		28,175	6,000
25	Macon, GA	4,100	9,000	
26	Buffalo, NY		78,400	
27	Albany, NY		46,100	8,840
28	Lititz, PA	2,400	39,250	
29	Culpeper, VA	12,050	3,472	
30	Charlotte, NC		39,868	
31	Tampa, FL		27,500	
32	Armstrong, B.C.	3,200		
33	Calgary, ALB.	17,450	5,000	3,000
34	Saskatoon, SASK.	11,340	3,000	3,000
35	Winnipeg, MAN.	4,290		
36	Toronto, ONT.	62,410	7,200	5,400
37	Montreal, QUE.	38,400	6,000	5,500

APPENDIX C

APPENDIX TABLE C1. OPTIMAL HRW WHEAT EXPORTS FROM EXPORTING COUNTRIES TO IMPORTING REGIONS, MODEL 1

	United States	Australia	Argentina
	-------1,000 Metric Tons---------		
NE Africa	307	1,500	0
NW Africa	685	0	0
China	3,027	457	300
S. Asia	698	0	315
SE Asia	0	252	1,646
W. Asia	5,250	160	550
E. Asia	2,460	900	0
FSU	3,698	0	0
W. Europe	28	0	0
W. S. America	1,386	0	0
N. S. America	173	0	0
E. S. America	0	0	1,441
EC	0	0	0
E. Europe	0	0	0
U.S.	--	--	--
Canada	0	--	--
Mexico	338	0	0
Total	18,050.00	3,269.00	4,252.00

APPENDIX TABLE C2. OPTIMAL HRS WHEAT EXPORTS FROM EXPORTING COUNTRIES TO IMPORTING REGIONS, MODEL 1

Import Region	United States	Canada
	-1,000 Metric Tons-	
NE Africa	25	0
NW Africa	0	325
China	0	3,644
S. Asia	0	511
SE Asia	0	1,710
W. Asia	521	1,057
E. Asia	0	3,082
FSU	1,213	2,863
W. Europe	102	0
W. S. America	0	415
N. S. America	0	622
E. S. America	1	215
EC	92	812
E. Europe	3	0
U.S.	--	0
Canada	0	--
Mexico	0	0
Total	1,957.00	15,256.00

APPENDIX TABLE C3. OPTIMAL SRW WHEAT EXPORTS FROM EXPORTING COUNTRIES TO IMPORTING REGIONS, MODEL 1

Import Region	United States	EC	Argentina
	-------1,000 Metric Tons--------		
NE Africa	3,580	217	0
NW Africa	900	1,157	0
China	2,033	2,997	0
S. Asia	0	2,830	0
SE Asia	0	628	0
W. Asia	0	2,184	0
E. Asia	2,256	0	0
FSU	1,919	1,919	0
W. Europe	0	73	0
W. S. America	109	0	0
N. S. America	63	0	0
E. S. America	12	0	9
EC	0	--	0
E. Europe	0	4,973	0
U.S.	--	--	--
Canada	711	--	--
Mexico	0	0	0
Total	11,584.00	16,978.00	9.00

APPENDIX TABLE C4. OPTIMAL DURUM WHEAT EXPORTS FROM EXPORTING COUNTRIES TO IMPORTING REGIONS, MODEL 1

Import Region	United States	Canada	EC
	-------1,000 Metric Tons---------		
NE Africa	212	0	0
NW Africa	1,833	240	0
China	33	0	0
S. Asia	0	0	0
SE Asia	0	0	0
W. Asia	77	0	77
E. Asia	208	0	0
FSU	547	547	0
W. Europe	0	0	23
W. S. America	10	0	0
N. S. America	0	64	169
E. S. America	54	0	0
EC	0	0	--
E. Europe	0	0	88
U.S.	--	120	--
Canada	0	--	--
Mexico	16	0	0
Total	2,990.00	971.00	357.00

APPENDIX D

APPENDIX TABLE D1. OPTIMAL HRW WHEAT EXPORTS FROM EXPORTING COUNTRIES TO IMPORTING REGIONS, MODEL 2

	United States	Australia	Argentina
	-------1,000 Metric Tons---------		
NE Africa	307	1,500	0
NW Africa	685	0	0
China	0	3,484	300
S. Asia	698	315	0
SE Asia	0	1,898	0
W. Asia	25	160	5,778
E. Asia	1,105	2,256	0
FSU	1,849	0	1,849
W. Europe	28	0	0
W. S. America	1,386	0	0
N. S. America	113	0	60
E. S. America	0	0	1,450
EC	49	0	543
E. Europe	3	0	0
U.S.	--	--	--
Canada	0	--	--
Mexico	338	0	0
Total	6,586.00	9,613.00	9,980.00

APPENDIX TABLE D2. OPTIMAL HRS WHEAT EXPORTS FROM EXPORTING COUNTRIES TO IMPORTING REGIONS, MODEL 2

Import Region	United States	Canada
	-1,000 Metric Tons-	
NE Africa	25	0
NW Africa	0	325
China	0	3,644
S. Asia	0	511
SE Asia	0	1,710
W. Asia	521	1,057
E. Asia	0	3,082
FSU	1,464	2,613
W. Europe	102	0
W. S. America	0	415
N. S. America	0	622
E. S. America	1	215
EC	313	0
E. Europe	3	0
U.S.	--	0
Canada	107	--
Mexico	0	0
Total	2,536.00	14,194.00

APPENDIX TABLE D3. OPTIMAL SRW WHEAT EXPORTS FROM EXPORTING COUNTRIES TO IMPORTING REGIONS, MODEL 2

Import Region	United States	EC	Argentina
	-------1,000 Metric Tons---------		
NE Africa	2,045	1,753	0
NW Africa	0	2,057	0
China	0	5,030	0
S. Asia	0	2,830	0
SE Asia	0	628	0
W. Asia	0	2,184	0
E. Asia	0	2,256	0
FSU	1,919	1,919	0
W. Europe	0	73	0
W. S. America	0	109	0
N. S. America	0	63	0
E. S. America	66	0	9
EC	0	--	0
E. Europe	0	4,973	0
U.S.	--	--	--
Canada	711	--	--
Mexico	16	0	0
Total	4,757.00	23,875.00	9.00

APPENDIX TABLE D4. OPTIMAL DURUM WHEAT EXPORTS FROM EXPORTING COUNTRIES TO IMPORTING REGIONS, MODEL 2

Import Region	United States	Canada	EC
	-------1,000 Metric Tons---------		
NE Africa	212	0	0
NW Africa	1,833	240	0
China	33	0	0
S. Asia	0	0	0
SE Asia	0	0	0
W. Asia	154	0	0
E. Asia	208	0	0
FSU	1,094	0	0
W. Europe	23	0	0
W. S. America	10	0	0
N. S. America	0	233	0
E. S. America	0	0	0
EC	0	0	--
E. Europe	0	0	88
U.S.	--	120	--
Canada	128	--	--
Mexico	0	0	0
Total	3,695.00	593.00	88.00

APPENDIX E

APPENDIX TABLE E1. OPTIMAL HRW WHEAT EXPORTS FROM EXPORTING COUNTRIES TO IMPORTING REGIONS, MODEL 3

Import Region	United States	Australia	Argentina
	-------1,000 Metric Tons---------		
NE Africa	1,807	0	0
NW Africa	685	0	0
China	1,175	2,609	0
S. Asia	0	0	1,013
SE Asia	0	660	1,238
W. Asia	5,734	0	226
E. Asia	3,360	0	0
FSU	3,698	0	0
W. Europe	28	0	0
W. S. America	1,386	0	0
N. S. America	173	0	0
E. S. America	0	0	1,441
EC	0	0	0
E. Europe	0	0	0
U.S.	--	--	--
Canada	0	--	--
Mexico	338	0	0
Total	18,384.00	3,269.00	3,918.00

APPENDIX TABLE E2. OPTIMAL HRS WHEAT EXPORTS FROM EXPORTING COUNTRIES TO IMPORTING REGIONS, MODEL 3

Import Region	United States	Canada
	--1,000 Metric Tons--	
NE Africa	25	0
NW Africa	325	0
China	0	3,644
S. Asia	0	511
SE Asia	0	1,710
W. Asia	789	789
E. Asia	0	3,082
FSU	103	3,974
W. Europe	0	102
W. S. America	0	415
N. S. America	0	622
E. S. America	216	0
EC	92	812
E. Europe	3	0
U.S.	--	0
Canada	0	--
Mexico	0	0
Total	1,553.00	15,661.00

APPENDIX TABLE E3. OPTIMAL SRW WHEAT EXPORTS FROM EXPORTING COUNTRIES TO IMPORTING REGIONS, MODEL 3

Import Region	United States	EC	Argentina
	-------1,000 Metric Tons---------		
NE Africa	2,436	1,361	0
NW Africa	2,057	0	0
China	2,033	2,998	0
S. Asia	0	2,830	0
SE Asia	0	628	0
W. Asia	0	2,184	0
E. Asia	2,256	0	0
FSU	1,919	1,919	0
W. Europe	0	73	0
W. S. America	109	0	0
N. S. America	63	0	0
E. S. America	0	21	0
EC	0	--	0
E. Europe	0	4,973	0
U.S.	--	--	--
Canada	711	--	--
Mexico	0	0	0
Total	11,584.00	16,987.00	0.00

APPENDIX TABLE E4. OPTIMAL DURUM WHEAT EXPORTS FROM EXPORTING COUNTRIES TO IMPORTING REGIONS, MODEL 3

Import Region	United States	Canada	EC
	-------1,000 Metric Tons---------		
NE Africa	212	0	0
NW Africa	2,073	0	0
China	33	0	0
S. Asia	0	0	0
SE Asia	0	0	0
W. Asia	77	0	77
E. Asia	208	0	0
FSU	547	547	0
W. Europe	0	0	23
W. S. America	10	0	0
N. S. America	0	203	30
E. S. America	0	0	0
EC	0	0	--
E. Europe	0	0	88
U.S.	--	120	--
Canada	0	--	--
Mexico	16	0	0
Total	3,176.00	870.00	218.00

APPENDIX F

APPENDIX TABLE F1. OPTIMAL HRW WHEAT EXPORTS FROM EXPORTING COUNTRIES TO IMPORTING REGIONS, MODEL 4

	United States	Australia	Argentina
	---------1,000 Metric Tons---------		
NE Africa	307	1,500	0
NW Africa	685	0	0
China	567	3,218	0
S. Asia	698	315	0
SE Asia	0	1,898	0
W. Asia	5,800	160	0
E. Asia	2,460	900	0
FSU	3,698	0	0
W. Europe	28	0	0
W. S. America	1,386	0	0
N. S. America	173	0	0
E. S. America	12	0	1,429
EC	0	0	0
E. Europe	0	0	0
U.S.	--	--	--
Canada	0	--	--
Mexico	338	0	0
Total	16,152.00	7,991.00	1,429.00

APPENDIX TABLE F2. OPTIMAL HRS WHEAT EXPORTS FROM EXPORTING COUNTRIES TO IMPORTING REGIONS, MODEL 4

Import Region	United States	Canada
	--1,000 Metric Tons--	
NE Africa	25	0
NW Africa	0	325
China	0	3,644
S. Asia	0	511
SE Asia	0	1,710
W. Asia	521	1,057
E. Asia	0	3,082
FSU	1,464	2,613
W. Europe	0	102
W. S. America	0	415
N. S. America	0	622
E. S. America	1	215
EC	321	582
E. Europe	3	0
U.S.	--	0
Canada	0	--
Mexico	0	0
Total	2,335.00	14,878.00

APPENDIX TABLE F3. OPTIMAL SRW WHEAT EXPORTS FROM EXPORTING COUNTRIES TO IMPORTING REGIONS, MODEL 4

Import Region	United States	EC	Argentina
	--------1,000 Metric Tons-------		
NE Africa	3,580	217	0
NW Africa	341	1,157	559
China	1,802	0	3,229
S. Asia	0	0	2,830
SE Asia	0	0	628
W. Asia	725	184	1,275
E. Asia	2,256	0	0
FSU	2,315	1,523	0
W. Europe	73	0	0
W. S. America	109	0	0
N. S. America	63	0	0
E. S. America	0	0	21
EC	0	--	0
E. Europe	0	4,973	0
U.S.	--	--	--
Canada	711	--	--
Mexico	0	0	0
Total	11,975.00	8,054.00	8,542.00

APPENDIX TABLE F4. OPTIMAL DURUM WHEAT EXPORTS FROM EXPORTING COUNTRIES TO IMPORTING REGIONS, MODEL 4

Import Region	United States	Canada	EC
	-------1,000 Metric Tons---------		
NE Africa	212	0	0
NW Africa	1,833	240	0
China	33	0	0
S. Asia	0	0	0
SE Asia	0	0	0
W. Asia	154	0	0
E. Asia	208	0	0
FSU	621	473	0
W. Europe	23	0	0
W. S. America	10	0	0
N. S. America	0	233	0
E. S. America	54	0	0
EC	0	0	--
E. Europe	0	0	88
U.S.	--	120	--
Canada	0	--	--
Mexico	16	0	0
Total	3,164.00	1,066.00	88.00

APPENDIX G

APPENDIX TABLE G1. OPTIMAL HRW WHEAT EXPORTS FROM EXPORTING COUNTRIES TO IMPORTING REGIONS, MODEL 5

	United States	Australia	Argentina
	-------1,000 Metric Tons---------		
NE Africa	1,807	0	0
NW Africa	685	0	0
China	0	3,784	0
S. Asia	698	1,013	0
SE Asia	0	1,898	0
W. Asia	5,960	0	0
E. Asia	2,041	1,319	0
FSU	3,698	0	0
W. Europe	28	0	0
W. S. America	1,386	0	0
N. S. America	173	0	0
E. S. America	1,441	0	0
EC	0	0	0
E. Europe	0	0	0
U.S.	--	--	--
Canada	0	--	--
Mexico	338	0	0
Total	18,255.00	8,014.00	0.00

APPENDIX TABLE G2. OPTIMAL HRS WHEAT EXPORTS FROM EXPORTING COUNTRIES TO IMPORTING REGIONS, MODEL 5

Import Region	United States	Canada
	--1,000 Metric Tons--	
NE Africa	25	0
NW Africa	325	0
China	0	3,644
S. Asia	0	511
SE Asia	0	1,710
W. Asia	789	789
E. Asia	0	3,082
FSU	570	3,507
W. Europe	102	0
W. S. America	0	415
N. S. America	0	622
E. S. America	216	0
EC	92	812
E. Europe	3	0
U.S.	--	0
Canada	0	--
Mexico	0	0
Total	2,122.00	15,092.00

APPENDIX TABLE G3. OPTIMAL SRW WHEAT EXPORTS FROM EXPORTING COUNTRIES TO IMPORTING REGIONS, MODEL 5

Import Region	United States	EC	Argentina
	-------1,000 Metric Tons---------		
NE Africa	1,893	0	1,904
NW Africa	2,057	0	0
China	1,802	0	3,229
S. Asia	0	0	2,830
SE Asia	0	0	628
W. Asia	1,092	0	1,092
E. Asia	2,256	0	0
FSU	1,919	1,651	268
W. Europe	73	0	0
W. S. America	109	0	0
N. S. America	63	0	0
E. S. America	0	0	21
EC	0	--	0
E. Europe	0	4,973	0
U.S.	--	--	--
Canada	711	--	--
Mexico	0	0	0
Total	11,975.00	6,624.00	9,972.00

APPENDIX TABLE G4. OPTIMAL DURUM WHEAT EXPORTS FROM EXPORTING COUNTRIES TO IMPORTING REGIONS, MODEL 5

Import Region	United States	Canada	EC
	-------1,000 Metric Tons---------		
NE Africa	212	0	0
NW Africa	2,073	0	0
China	33	0	0
S. Asia	0	0	0
SE Asia	0	0	0
W. Asia	154	0	0
E. Asia	208	0	0
FSU	621	473	0
W. Europe	23	0	0
W. S. America	10	0	0
N. S. America	0	233	0
E. S. America	0	0	0
EC	0	0	--
E. Europe	0	0	88
U.S.	--	120	--
Canada	0	--	--
Mexico	16	0	0
Total	3,350.00	826.00	88.00

APPENDIX H

APPENDIX TABLE H1. OPTIMAL HRW WHEAT EXPORTS FROM EXPORTING COUNTRIES TO IMPORTING REGIONS, MODEL 6

Import Region	United States	Australia	Argentina
	-------1,000 Metric Tons---------		
NE Africa	307	1,500	0
NW Africa	685	0	0
China	3,027	457	300
S. Asia	698	0	315
SE Asia	0	252	1,646
W. Asia	5,250	160	550
E. Asia	2,460	900	0
FSU	3,698	0	0
W. Europe	28	0	0
W. S. America	1,386	0	0
N. S. America	173	0	0
E. S. America	0	0	1,441
EC	0	0	0
E. Europe	0	0	0
U.S.	--	--	--
Canada	0	--	--
Mexico	339	0	0
Total	18,051.00	3,269.00	4,252.00

APPENDIX TABLE H2. OPTIMAL HRS WHEAT EXPORTS FROM EXPORTING COUNTRIES TO IMPORTING REGIONS, MODEL 6

Import Region	United States	Canada
	--1,000 Metric Tons--	
NE Africa	25	0
NW Africa	0	325
China	0	3,644
S. Asia	0	511
SE Asia	0	1,710
W. Asia	521	1,057
E. Asia	0	3,082
FSU	1,464	2,613
W. Europe	0	102
W. S. America	0	415
N. S. America	0	622
E. S. America	1	215
EC	107	797
E. Europe	3	0
U.S.	--	402
Canada	0	--
Mexico	0	0
Total	2,121.00	15,495.00

APPENDIX TABLE H3. OPTIMAL SRW WHEAT EXPORTS FROM EXPORTING COUNTRIES TO IMPORTING REGIONS, MODEL 6

Import Region	United States	EC	Argentina
	-------1,000 Metric Tons---------		
NE Africa	2,045	1,753	0
NW Africa	0	2,057	0
China	2,067	2,963	0
S. Asia	0	2,830	0
SE Asia	0	628	0
W. Asia	0	2,184	0
E. Asia	2,256	0	0
FSU	1,919	1,919	0
W. Europe	0	73	0
W. S. America	37	71	0
N. S. America	0	63	0
E. S. America	12	0	9
EC	0	--	0
E. Europe	0	4,973	0
U.S.	--	--	--
Canada	711	--	--
Mexico	2,572	0	0
Total	11,288.00	19,514.00	9.00

APPENDIX TABLE H4. OPTIMAL DURUM WHEAT EXPORTS FROM EXPORTING COUNTRIES TO IMPORTING REGIONS, MODEL 6

Import Region	United States	Canada	EC
	-------1,000 Metric Tons---------		
NE Africa	212	0	0
NW Africa	1,833	240	0
China	33	0	0
S. Asia	0	0	0
SE Asia	0	0	0
W. Asia	77	0	77
E. Asia	208	0	0
FSU	547	547	0
W. Europe	0	0	23
W. S. America	0	0	10
N. S. America	0	54	179
E. S. America	54	0	0
EC	0	0	--
E. Europe	0	0	88
U.S.	--	120	--
Canada	0	--	--
Mexico	100	195	0
Total	3,064.00	1,156.00	377.00

APPENDIX I

APPENDIX TABLE I1. OPTIMAL HRW WHEAT EXPORTS FROM EXPORTING COUNTRIES TO IMPORTING REGIONS, MODEL 7

Import Region	United States	Australia	Argentina
	-------1,000 Metric Tons---------		
NE Africa	1,807	0	0
NW Africa	685	0	0
China	0	3,784	0
S. Asia	0	1,013	0
SE Asia	0	1,898	0
W. Asia	997	4,678	285
E. Asia	0	3,360	0
FSU	3,698	0	0
W. Europe	28	0	0
W. S. America	1,386	0	0
N. S. America	0	0	173
E. S. America	0	0	1,441
EC	0	0	0
E. Europe	0	0	0
U.S.	--	--	--
Canada	0	--	--
Mexico	338	0	0
Total	8,939.00	14,733.00	1,899.00

APPENDIX TABLE I2. OPTIMAL HRS WHEAT EXPORTS FROM EXPORTING COUNTRIES TO IMPORTING REGIONS, MODEL 7

Import Region	United States	Canada
	--1,000 Metric Tons--	
NE Africa	25	0
NW Africa	325	0
China	0	3,644
S. Asia	0	511
SE Asia	0	1,710
W. Asia	789	789
E. Asia	0	3,082
FSU	773	3,303
W. Europe	102	0
W. S. America	0	415
N. S. America	0	622
E. S. America	216	0
EC	92	812
E. Europe	3	0
U.S.	--	428
Canada	107	--
Mexico	0	0
Total	2,432.00	15,316.00

APPENDIX TABLE I3. OPTIMAL SRW WHEAT EXPORTS FROM EXPORTING COUNTRIES TO IMPORTING REGIONS, MODEL 3

Import Region	United States	EC	Argentina
	-------1,000 Metric Tons---------		
NE Africa	998	2,800	0
NW Africa	2,058	0	0
China	1,528	0	3,502
S. Asia	0	0	2,830
SE Asia	0	0	628
W. Asia	0	1,092	1,092
E. Asia	2,256	0	0
FSU	1,919	1,919	0
W. Europe	0	73	0
W. S. America	109	0	0
N. S. America	63	0	0
E. S. America	0	0	21
EC	0	--	0
E. Europe	0	4,973	0
U.S.	--	--	--
Canada	711	--	--
Mexico	1,470	0	0
Total	11,112.00	10,587.00	8,073.00

APPENDIX TABLE I4. OPTIMAL DURUM WHEAT EXPORTS FROM EXPORTING COUNTRIES TO IMPORTING REGIONS, MODEL 7

Import Region	United States	Canada	EC
	-------1,000 Metric Tons---------		
NE Africa	212	0	0
NW Africa	2,073	0	0
China	33	0	0
S. Asia	0	0	0
SE Asia	0	0	0
W. Asia	154	0	0
E. Asia	208	0	0
FSU	547	547	0
W. Europe	23	0	0
W. S. America	0	10	0
N. S. America	0	233	0
E. S. America	0	0	0
EC	419	0	--
E. Europe	88	0	0
U.S.	--	381	--
Canada	0	--	--
Mexico	316	0	0
Total	4,073.00	1,171.00	0.00