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on the International Trade of Soybeans and
Soybean Products

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Abstract

The objective of this paper is to investigate the impacts of implementation of the FTAA and China's lower import tariffs on international trade of soybean oil, soybean meal, and soybeans. A two-commodity spatial model was formulated. The base model was calibrated to simulate the average level data of 1996, 1997, and 1998. Two alternative trade scenarios were simulated. The results indicated that the implementation of FTAA and China's WTO accession would generally result in higher soybean oil, soybean meal, and soybean trade. Additionally, output expansion by Brazil would harm the overall U.S. soybean and soybean product export sectors.

Introduction

Several trade-related events are expected to have significant impacts on international trade of soybeans and soybean products. First is the acceptance of China as a member of World Trade Organization (WTO) in December 2001. Being one of the major importers of soybeans and soybean products, China's recent membership into the WTO would likely result in significant changes in soybeans and soybean product import from the Western Hemisphere. By the year the Free Trade Area of the Americas (FTAA) is implemented, China's bound rates on soybean oil, soybean meal, and soybeans are expected to be 9%, 5%, and 3%, respectively. It is ex-

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pected that these reductions in tariffs would increase import demands for soybeans and soybean products from the Western Hemisphere.

Second is the implementation of the FTAA in late 2005 or early 2006. The implementation of this regional trade agreement has the potential of creating trade diversion and trade creation, causing changes in trade pattern, volumes and composition.

Finally, it is anticipated that Brazil will expand its soybean and soybean product sectors. This is anticipated because the Brazilian government has singled-out the soybean industry for accelerated expansion to alleviate pressure for foreign exchange and to encourage development of the processing sector in its economy (USDA, 2001).

The objective of this paper is to analyze the effects of changes mentioned above on international trade of soybeans and soybean products. Realizing the objective would allow us to evaluate how the interest of the U.S. soybean and soybean product sectors are affected by these changes, especially relative to its biggest competitor, Brazil.

Method and Data

To analyze these changes, a spatial equilibrium model was formulated. All countries and regions in the Western Hemisphere were included in the model along with several countries and regions outside the Western Hemisphere, namely the EU, China, Japan, and Middle-east and North Africa, and the rest of the world. The specification of the model was based on one of the approaches prescribed by Takayama and Judge (1971) where the objective function was specified in net social monetary gain. In the model, soybean oil and soybean meal were treated as intermediate products and soybeans as the primary product.

To simplify the model discussion, a two-country model is presented. The full model is obtained by extending the two-country model to n regions, with n equal to 17. In the model, other oilseed substitutes were not explicitly included. This was deemed justifiable because soybeans make up the largest portion of oilseeds consumed, while soybean meal and soybean oil respectively are the largest portions of protein meal and vegetable oil consumed in the world.

Soybean oil demand (QOD_i) and soybean oil supply (QOP_i) in Country i are:

$$(1) \quad QOD_i = a_{i1} - b_{i1}PO_i, \text{ and}$$

$$(2) \quad QOP_i = k_{i1} \cdot QBC_i.$$

As shown in equation (1), soybean oil demand is downward sloping and is a function of its own price (PO_i). Parameters a_{ij} and b_{ij} are positive constants. In equation (2), k_{i1} is the soybean oil extraction rate and QBC_i is the quantity of soybeans crushed in Country i . Since the soybean oil supply is the product of k_{i1} and QBC_i , the supply schedule is vertical with magnitude dependent on the quantity of soybeans crushed. Soybean meal demand (QMD_i) and soybean meal supply (QMP_i) in Country i are:

$$(3) \quad QMD_i = a_{i2} - b_{i2}PM_i, \text{ and}$$

$$(4) \quad QMP_i = k_{i2} \cdot QBC_i.$$

Similar to soybean oil, soybean meal demand is negatively sloped and is a function of its own price (PM_i). Soybean meal supply equals its extraction rate, k_{i2} , times QBC_i and is vertical. Demand for soybeans for crushing in Country i is:

$$(5) \quad QBC_i = a_{i3} + b_{i3}CM_i.$$

In equation (5), CM_i is the crushing margin in Country i , where

$$(6) \quad CM_i = k_{i1}PO_i + k_{i2}PM_i - PB_i$$

where PB_i is the price of soybean in Country i . Substituting (6) into (5), we get:

$$(7) \quad QBC_i = a_{i3} + b_{i3}k_{i1}PO_i + b_{i3}k_{i2}PM_i - b_{i3}PB_i.$$

As shown in equation (7), the demand of soybeans for crushing is negatively sloped with respect to soybean price.

Soybean oil demand (QOD_j) and soybean oil supply (QOP_j) in Country j are:

$$(8) \quad QOD_j = a_{j1} - b_{j1}PO_j, \text{ and}$$

$$(9) \quad QOP_j = k_{j1} \cdot QBC_j.$$

Meal demand and supply in Country j are:

$$(10) \quad QMD_j = a_{j2} - b_{j2}PM_j, \text{ and}$$

$$(11) \quad QMP_j = k_{j2} \cdot QBC_j.$$

In terms of soybean oil, soybean meal and soybean prices, soybean demand for crushing in Country j is:

$$(12) \quad QBC_j = a_{j3} + b_{j3}k_{j1}PO_j + b_{j3}k_{j2}PM_j - b_{j3}PB_j.$$

Price linkages between exporting and importing countries for soybean oil, soybean meal, and soybeans are established through their respective transfer costs as follows:

$$(13) \quad PO_i = PO_j + to_{ji},$$

$$(14) \quad PM_i = PM_j + tm_{ji},$$

$$(15) \quad PB_i = PB_j + tb_{ji},$$

where parameters to_{ji} , tm_{ji} , and tb_{ji} are transfer costs of soybean oil, soybean meal, and soybeans from Country j to Country i , respectively.

Conceptually, total supply should equal total demand. As such, the market clearing identities for the three commodities are:

$$(16) \quad QOP_i + QOP_j = QOD_i + QOD_j,$$

$$(17) \quad QMP_i + QMP_j = QMD_i + QMD_j, \text{ and}$$

$$(18) \quad QBPC_i + QBPC_j = QBC_i + QBC_j.$$

The allocations of soybeans for crushing in Country i and Country j are fractions of total soybeans produced in each respective country. This is because some portions of soybeans produced go to feed, seed, waste, and food use. Thus the quantity of soybeans produced and quantity of soybeans produced for crushing are related as follows:

$$(19) \quad QBPC_i = \mathbf{d}_i QBS_i, \text{ and}$$

$$(20) \quad QBPC_j = \mathbf{d}_j QBS_j,$$

where \mathbf{d}_i and \mathbf{d}_j are fractions less than one, and QBS_i and QBS_j are quantity of soybeans produced in Country i and Country j , respectively.

Since there are only two countries with a marketing channel going from j to i , the imports of Country i should equal the exports of Country j . For the importing country, total volume of import plus the quantity domestically produced less the quantity domestically consumed should equal zero. Thus for each commodity, the following equations should hold. That is,

$$(21) \quad XO_{ji} + QOP_i - QOD_i = 0,$$

$$(22) \quad XM_{ji} + QMP_i - QMD_i = 0, \text{ and}$$

$$(23) \quad XB_{ji} + QBPC_i - QBC_i = 0.$$

In equation (21) through (23), XO_{ji} , XM_{ji} , and XB_{ji} respectively are volume of soybean oil, soybean meal, and soybeans shipments from Country j to Country i .

For the exporting country, the quantity domestically produced less the quantity shipped to the importing country and the quantity domestically consumed should equal to zero. Thus the following equations should hold.

$$(24) \quad -XO_{ji} - QOD_j + QOP_j = 0,$$

$$(25) \quad -XM_{ji} - QMD_j + QMP_j = 0, \text{ and}$$

$$(26) \quad -XB_{ji} - QBC_j + QBPC_j = 0.$$

Country-wise data on production, consumption, trade (import and export), soybean oil and meal conversion factors were taken from *PS&D View*. Prices were obtained from FAO World Trade Yearbook. The base model was calibrated to simulate the average level data of 1996, 1997, and 1998. The base model was then modified to simulate two alternative trade scenarios.

In the first scenario, it was assumed that (i) FTAA fully liberalized soybean and soybean products trade, and (ii) China's tariffs on soybean oil, soybean meal, and soybeans were reduced to 9%, 5%, and 3%, respectively. In the second scenario, the base model was altered to incorporate assumptions of scenario one and the additional assumption that Brazil expands soybean harvested area by 10%.

Simulation Results

Simulation of scenario one produced the following results. The price impacts are presented in Table 1. As shown by the figures in the table, liberalization would result in lower world price of soybean oil and soybean meal, but higher soybean world price. As expected, the average domestic price of soybean oil, soybean meal, and soybeans in exporting countries go up while the average domestic price of soybean oil, soybean meal, and soybeans in importing countries go down. These changes would stimulate world trade in soybean oil and soybean meal.

Table 1: Impacts on prices, percent change from baseline.

	Prices (World)	Av. Dom. Prices in Exporting countries	Av. Dom. Prices in Importing countries
Soybean oil	-8.4	5.8	-18.4
Soybean meal	-21.2	3.1	-31.4
Soybeans	12.5	28.0	-18.7

As shown in Table 2, world trade in soybean oil and meal increased significantly from the baseline where world trade in soybean oil and soybean meal increased by 23% and 18% respectively. However, world soybean trade does not change much from the baseline figure. Soybean oil trade within the Western Hemisphere (WH) increased by about 40%. Soybean meal trade increased by merely 1% while trade in soybeans decreased by about 2%.

Table 2: Impacts on trade, percent change from baseline.

	Trade volumes (World)	Trade volumes (WH Importing countries)
Soybean oil	22.5	40.1
Soybean meal	18.0	1.0
Soybeans	0.5	-2.4

Table 3 shows the impacts on consumption in several selected regions in the model. The results indicated that China's consumption of soybean products would increase while soybean

crushing would decrease by almost 4%. For the Western Hemisphere, the consumption of soybean oil increased by about 18%. The results also indicated that soybean processing in the U.S. would decrease by almost 2% while processing in Brazil would increase by almost 3%.

Table 3: Impacts on consumption, percent change from baseline.

Regions	Soybean Oil Consumption	Soybean Meal Consumption	Soybean Crushed
U.S.	-4.0	-13.6	-1.5
Argentina	-9.4	-33.4	0.2
Brazil	-16.3	-25.3	2.8
EU	-7.2	-19.6	7.4
China	24.2	13.0	-3.8
Japan	-0.6	12.7	-0.6
WH*	18.2	-0.5	-2.4
ROW	-3.8	46.8	-3.2

* Western Hemisphere importing countries.

Table 4 shows the impacts on exports of the U.S. and Brazil. Liberalization would result in the U.S. having higher exports in soybean oil, soybean meal, and soybeans. At the same time, the U.S. also attains larger export market shares in all commodities. In terms of export revenue (calculated at the world price), the aggregate U.S. export revenue would increase by a total of \$1,340 million. In spite of the small percentage gain, much of the increase in revenue would come from higher soybean exports.

On the other hand, Brazil would have higher soybean oil and meal export, but its soybean export decrease by about 10%. Accordingly, its soybean export market share declined by about two percentage points. These changes would result in Brazil attaining higher aggregate export

revenue of about \$114 million. The increase would largely come from higher soybean oil exports.

Table 4: Impacts on exports, percent change from baseline.

	Change in Export (US)	Change in Market share (US)	Change in Export (Brazil)	Change in Market share (Brazil)
Soybean oil	29.7	From 11.6 to 12.3	51.9	From 24.2 to 30.0
Soybean meal	55.6	From 19.3 to 25.5	17.9	From 38.4 to 38.5
Soybeans	2.4	From 74.2 to 75.6	-10.4	From 17.4 to 15.6

Simulation results of the second scenario indicated that world price of soybean oil, soybean meal, and soybeans would decrease. The largest decrease would be in soybean oil price. As in the previous scenario, average domestic price of soybean oil, soybean meal, and soybeans in importing countries go down. However, only the average domestic price of soybean oil in exporting countries would go up. Average domestic price of soybean meal and soybeans in exporting countries go down.

Table 5: Impacts on prices, percent change from baseline.

	Prices (World)	Av. Dom. Prices in Exporting countries	Av. Dom. Prices in Importing countries
Soybean oil	-9.3	3.9	-18.5
Soybean meal	-4.8	-2.3	-5.8
Soybeans	-4.0	-5.6	-0.8

Accordingly, with lower prices and larger supply, world trade volumes in soybean oil, soybean meal, and soybeans go up (Table 6), with largest percentage increase in soybean oil trade. However, in the Western Hemisphere, only soybean oil and meal trade would go up. Soybean trade in the Western Hemisphere remains largely unchanged.

Table 6: Impacts on trade, percent change from baseline.

	Trade volumes (World)	Trade volumes (WH: Importing countries)
Soybean oil	21.3	31.9
Soybean meal	3.3	20.1
Soybeans	1.1	-0.1

Table 7 shows the impacts on consumption. As in the first scenario, China's consumption of soybean oil and meal would increase while soybean crushing would decrease by almost 5%. For the Western Hemisphere, the consumption of soybean oil and meal increased by about 16% and 9% respectively. Unlike the previous scenario, the results indicated that soybean processing in the U.S. would increase by almost 7% while processing in Brazil would decrease by almost 2%.

Table 8 shows the impacts of liberalization on U.S. and Brazil's exports. Higher soybean supply from Brazil and liberalization would result in the U.S. having higher exports in soybean oil and soybean meal, but lower soybean export. At the same time, the U.S. would attain larger export market shares only in soybean oil and meal sectors. In terms of export revenue (calcu-

lated at the world price), the aggregate U.S. export revenue would decrease by a total of \$20 million. The decrease is a result of lower soybean exports and world price.

Table 7: Impacts on consumption, percent change from baseline.

Regions	Soybean Oil Consumption	Soybean Meal Consumption	Soybean Crushed
U.S.	-2.2	0.0	6.8
Argentina	3.1	-2.7	-3.8
Brazil	-9.7	4.2	-1.9
EU	-5.8	-9.4	6.9
China	25.3	28.7	-5.0
Japan	-0.3	2.3	-4.9
WH*	15.7	9.2	-0.2
ROW	-3.0	3.1	0.6

* Western Hemisphere importing countries.

Table 8: Impacts on exports, percent change from baseline.

	Change in Export (US)	Change in Market share (US)	Change in Export (Brazil)	Change in Market share (Brazil)
Soybean oil	119.3	From 11.6 to 21.0	18.3	From 24.2 to 23.6
Soybean meal	38.6	From 19.3 to 25.9	-5.2	From 38.4 to 35.3
Soybeans	-11.0	From 74.2 to 65.4	40.4	From 17.4 to 24.2

On the other hand, Brazil would have higher soybean oil and soybeans export. Its exports in soybean meal decreased by about 5%. In export market share, Brazil's export share in soybean oil and meal decreased while its export shares in soybeans increased by almost seven

percentage points. These changes would result in Brazil attaining higher aggregate export revenue of about \$260 million. The increase largely comes from higher soybean exports.

Conclusions

The objective of this paper was to investigate the impacts of the implementation of FTAA and China's lower import tariffs on international trade of soybean oil, soybean meal, and soybeans. For that purpose, a two-commodity spatial equilibrium model was formulated. The base model was calibrated to simulate the average level data of 1996, 1997, and 1998. Two alternative trade scenarios were simulated. In the first scenario, it was assumed that FTAA fully liberalized soybean and soybean products trade, and China's tariffs on soybean oil, soybean meal, and soybeans were reduced to 9%, 5%, and 3%, respectively. In the second scenario, the base model was altered to incorporate assumptions of the first scenario and the additional assumption that Brazil expands soybean harvested area by 10%.

From the simulation results, it could be concluded that the implementation of FTAA and China's WTO accession would generally result in soybean oil and meal consumption increase in importing countries. However, processing activities in importing countries would decline. As such, the increase in consumption of soybean products result is the result of higher imports of soybean products from the Western Hemisphere.

In addition, in spite of the higher U.S. exports and market share in soybean oil and soybean meal, output expansion by Brazil would harm the overall U.S. soybean and soybean product export sectors. However, the reduction in aggregate export revenue is not large and could be compensated by the increase in value-added from higher soybean processing activities.

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