An Assessment of the Global Soybean Industry: An Application of Stochastic Equilibrium Displacement Model

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Abstract:

This study uses stochastic equilibrium displacement model (SEDM) to investigate the impact on the soybean and its joint products (soymeal and soyoil) sectors of different countries and regions from transportation cost reduction in Brazil incorporating assumptions of decrease in the U.S. loan deficiency payment. Export cost competitiveness analysis was performed to compare the effectiveness of transportation costs of U.S., Brazil and Argentina. Two alternative scenarios are constructed and solved to quantify the economic impact in terms of in terms of trade flows, demand and supply, and price. The results indicate that Brazil will benefit from the reduction in transportation costs and become more competitive in the soybean global market. In general, the oilseed importing countries will increase their soybean import. Very little improvement of exporting competitiveness for the soybean joint products is shown for Brazil. U.S. will experience a loss of competitiveness in the international soybean world market resulted from loan deficiency payment reduction.

Keywords: International Trade, Loan Deficiency Payment, Soybean, Soybean Joint Products, Stochastic Equilibrium Displacement Model, Transportation Costs

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1. Introduction

According to Foreign Agricultural Service/USDA (2006), Brazil, the United States and Argentina are the three largest soybean exporters in the global market, which accounted for about 90% of the world total soybean exports for 2005/06 market year. In the same market year, for soymeal and oil, this proportion was 86 and 88%, respectively.

Through out years, Brazil has relatively higher transportation costs compared to the United States, which dampens the soybean producers' competitiveness in soybean exports in the global market. In the past few decades, actions have been taken to improve the infrastructure. It is generally accepted that the improvement would consequently reduce soybean transportation costs and enhance the competitiveness of Brazil as a soybean export competitor in the international market. With adequate roads built, freight costs will be reduced and utilization of roads with other less costly ways of transportation, such as waterways and railroads would prevail.

The U.S. farm program has long been supporting the soybean industry to maintain price competitiveness for domestically produced soybean on the global market. The loan deficiency payment (LDP) is directly coupled with current soybean production decision. Any change in LDP is expected to impact the U.S. domestic as well as international soybean industry.

The primary objective of this study is to analyze and evaluate the impact of reduction in transportation costs in Brazil and U.S. LDP on soybean and its joint products sectors in terms of trade flows, demand and supply, and price in Brazil, the United States, Argentina, China and Japan, and the European Union. This study will greatly assist soybean producers in Brazil, the United States, and Argentina as an important source to assess the current situation of soybean industry, comprehend the impact of all exogenous policy shocks, and rationally adjust production and export decisions accordingly.

2. Overview of the world soybean industry market and barriers to free trade

2.1. The export competitiveness between Brazil, United States, and Argentina

A natural barrier to free trade is transportation costs. The country which possesses the less expensive way of shipping its product overseas has significant advantage compared to its counterparts. Here we introduce the concept of export cost competitiveness. This concept sums up production costs, internal transportation costs, and freight costs for each exporting country and compare among them. The country that has the lowest cost at the importing port is considered the most efficient one. In this study, we estimated the export cost competitiveness for the MY 2003/04. The methodology was the same used by Schnepf et al and the estimations are presented in Table 1.

In Table 1, we can see that Brazil and Argentina are more competitive on the production side than the U.S. The U.S. is more efficient than Brazil and Argentina in the variable costs aspects. On the other hand, the fixed costs in the U.S are extremely high compared to the South American counterparts, especially Brazil. Although the total production cost is less expensive in Brazil and Argentina, the internal transportation costs are considerably higher when compared to the U.S. The reason for such high transportation costs in Brazil can be explained by the farm-port distance (from MT to port is more than 1500 kms), lack of paved roads and navigable waterways, and small numbers of railroads.

In summary, the internal transportation from farm to the port and shipping costs to the import port plays a crucial role in the export cost competitiveness by narrowing the spread between the three major soybean exporters. Lastly, estimating the transportation cost for these three countries serves as a measurement tool as to what rates should be adopted to shock the model.

Table 1. Soybean production costs and export cost competitiveness: U.S., Brazil (Mato Grosso and Paraná), and Argentina (2003/04).

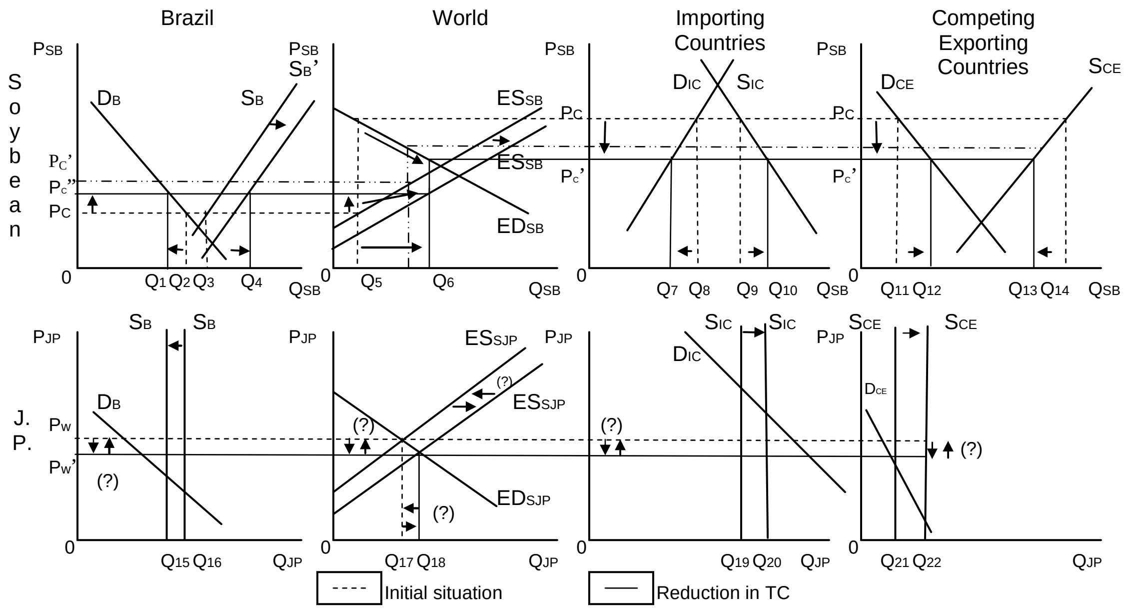
Cost Item	U.S. Heartland	Brazil MT	Brazil Paraná	Argentina
	US $ per acre			
Variable costs:				
Seed	28.67	12.79	10.54	18.57
Fertilizers	7.73	47.00	22.22	6.26
Chemicals	17.10	35.47	38.61	17.56
Machine Operation Repair	22.13	18.02	22.82	21.36
Interest on Capital	1.00	7.38	5.32	9.87
Hired Labor	1.26	1.46	5.59	6.08
Harvest	n/a	5.52	8.22	12.49
Miscellaneous	n/a	1.57	2.02	n/a
Total variable costs	**77.88**	**129.21**	**115.35**	**92.21**
Fixed Costs:				
Depreciation of machinery	51.36	16.83	18.96	22.14
Land costs (rental rate)	97.45	15.46	25.91	72.78
Taxes and insurance	5.92	2.81	4.63	n/a
Farm overhead	12.23	2.54	1.91	23.98
Total fixed Costs	**166.96**	**37.63**	**51.40**	**118.90**
Total production costs	**244.84**	**166.84**	**166.75**	**211.11**
Costs per bushel:	*US $ per bushel (% of U.S. cost)*			
Yield (bushels/acre)	46.00	43.07	41.38	50.00
Variable costs per bushel	1.69	3.00	2.79	1.84
Fixed costs per bushel	3.63	0.87	1.24	2.38
Total costs per bushel	**5.32**	**3.87 (73)**	**4.03 (76)**	**4.22 (79)**
Internal trans. (US $/bu.)	0.48	1.80	0.81	0.72
Cost at border	**5.81**	**5.67 (98)**	**4.84 (83)**	**4.94 (85)**
Freight costs to Rotterdam	0.39	1.25	1.25	1.03
Price at Rotterdam	**6.20**	**6.92 (112)**	**6.09 (98)**	**5.97 (96)**

Source: ERS/USDA (2006), Schnepf et al., Rebolini (2005), Conab (2006) Paraná State Department of Agriculture (SEAB) (2006), CIF Rotterdam prices (FAS/USDA, 2006); U.S. FOB Gulf port prices (ASA, 2006); U.S. producer price (NASS/USDA, 2006); Argentinean internal transportation and marketing costs to port: Schnepf et al. and Lence; Brazil FOB prices are from Rio Grande (Safras and Mercado) and Paranagua (Reuters) (FAS/USDA, 2006).

2.2. Conceptual analysis of transportation costs reduction in Brazil

The effects of Brazil's reduction in transportation costs on the soybean industry world market are illustrated in Figure 1. The effects of an improvement in transportation costs on a large exporter country and its effect on the world market, including importers and competing exporters, can be depicted in a partial equilibrium framework.

Figure 1. Effects of reduction in transportation costs in Brazil and in the world soybean industry market



Source: authors' construction.

The initial situation amid no improvement in transportation costs is represented by the dotted line. Since Brazil is a large soybean exporting country, as Brazil reduces its transportation costs, the soybean domestic price goes up to P_C'. Consequently, the soybean price in the importing countries and competing exporting countries drops to a level represented by the long dash double dot line (right above the black line). However, the decrease in transportation costs becomes an attraction for Brazilian soybean producers to expand their crop. As a result of the expansion, the soybean supply in Brazil increases shifting the supply curve outward (S_B to S_B'). As a consequence of the soybean increase, the world excess supply moves in the same direction as the Brazil's soybean supply (ES_{SB} to ES_{SB}'). Therefore, the domestic soybean price in Brazil reaches P_C" capturing both local transportation costs reduction and soybean crop expansion effects. As a result, the domestic consumption of soybean by the joint sectors decreases from Q_2 to Q_1. On the other hand, Brazil's soybean exports rises from $Q_2 – Q_3$ to Q_1 - Q_4. For the rest of the world (importing countries and competing exporting countries), the soybean price goes down which causes an increase of soybean imports (from Q_8 - Q_9 to $Q_7 – Q_{10}$) and decrease in exports (from $Q_{11} – Q_{14}$ to $Q_{12} – Q_{13}$) for the importing and competing exporting countries, respectively. The total soybean world trade is illustrated in the figure by $0 – Q_6$, which represents a raise compared to the initial situation.

As for the soybean joint products sector, the total effects are ambiguous. The magnitude of the soybean supply shift has a crucial role in determining the soybean joint products excess supply movement. In Figure 1, the domestic soybean price increases in Brazil and goes down for the rest of the world. Since soybean are the primary input for the soybean industry and approximately 60%[1] of the soybean is crushed in the exporting countries, the soybean crush decreases in Brazil and increases for the importing and exporting competing countries. Consequently, soymeal and soyoil supply increases for both importing and competing exporting countries. Nevertheless, the effect on the soybean derived products world price and trade flows are uncertain. In addition, the

[1] For 2004/05 MYs, the proportion of produced soybean destined to crushing for Brazil, US, and Argentina, is 55%, 54.3%, and 70%, respectively (FAS/USDA, 2006). Hence, the average is 60%.

excess supply might shift to the right, stay in the same position, or even, but not likely[2], shift inward.

2.2. U.S. farm program

U.S. soybean production has long been supported by a U.S. farm program. One of the major purposes of the 2002 U.S. farm program is to maintain price competitiveness for domestically produced soybean on the international market through three programs: direct payments, marketing loans, and a counter-cyclical payment.

The marketing loan program allows producers to receive a loan at a specific loan rate per unit of production. It provides a LDP or marketing loan gain to producers when market prices are low. When market prices are below the loan rate[3], farmers are allowed to repay commodity loans at a loan repayment rate that is lower than the loan rate. Alternatively, loan program benefits can be taken directly as loan deficiency payments.

The 2002 Farm Act affects the crop sector primarily through acreage and production changes. Among the three programs in farm bill, LDP has the greatest effect on production because it is directly coupled to producers' current production decision. Therefore, LDP reduction is included in this study as an important exogenous variable. The policy implication of LDP reduction in the United States will be simulated.

3. Methodology

To quantify the impact of a reduction in transportation costs through improvement in infrastructure in Brazil and reduction in U.S. LDP rate, an economic model was specified to capture the basic linkages of soybean industry. A stochastic equilibrium

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[2] Although Brazil is respectively the second and third largest exporter of soymeal and soyoil in the market, this amount represents 28% of the world total exports (FAS/USDA, 2006).
[3] LDP payment rate is $5.00/bushel for soybean for 2002-2007.

displacement model was then developed to quantify such impacts on the oilseed and soybean joint products sectors.

3.1. Theoretical Considerations

Soybean oilseed and its joint products production, consumption, and trade are modeled on the basis of modern economic consumer and producer theory. Nonjointness of production is assumed[4]. If domestic and import soybean joint products are not perfectly substitutable, the following demand function can be defined:

$OMD_D = OMD_D(POMD, POMD_M ,PX, Y)$

$OMD_M = OMD_M(POMD, POMD_M, PX, Y)$

where OMD_D and OMD_M are a country's domestic and import demand for soymeal and soyoil, respectively. POMD, $POMD_M$, and PX are price vectors of domestic soybean joint products, imported soybean joint products, and other goods, respectively, and Y is per capita income.

Given perfect competition, by Shepard's lemma, output supply and input demand were characterized as P = AC(W) and X = X(W, Z) where AC is average cost function, P is output price vector, W is the input price vector, X is input vector, and Z is output vector.

3.2. Analytical model

Based on considerations mentioned above, an economic model was developed to reflect the linkage of the oilseed and joint products. The world's soybean industry nations

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[4] A multioutput industry's supply and demand has the same properties as a single output industry. According to Hall, the necessary and sufficient condition for nonjointness technology is that the total cost of producing all outputs is the sum of cost of producing each output separately: $C(Y,W)=C^1(Y^1,W)+\ldots\ldots+C^n(Y^n,W)$ where C(Y,W) is the total cost function, C^i is the cost function producing output I, Y^i is the ith ouput, and W is the vector of input prices. If the technology has constant returns to scale, the total cost function can further specified as $C(Y,W)=Y^1b^1(W)+\ldots..+Y^nb^n(W)$.

are divided into six groups: (i) exporters – Brazil, U.S., and Argentina; and (ii) importers – EU, Asia (Japan and China), and Rest of the World (ROW). The model is specified as below, where i refers to Brazil, U.S., and Argentina, j stands for EU, Asia, and ROW:

I. Soybean joint products (soymeal and soyoil).

Consumption

(1) $MD_j = MD_j\,(PMD_j, PMM_j)$

(2) $OD_j = OD_j\,(POD_j, POM_j)$

(3) $MM_j = MM_j\,(PMD_j, PMM_j)$

(4) $OM_j = OM_j\,(POD_j, POM_j)$

Production

(5) $PMD_j = AC\,(PB_j, PB_i)$

(6) $POD_j = AC\,(PB_j, PB_i)$

(7) $PMS_i = AC(PB_i)$

(8) $POS_i = AC(PB_i)$

II. Soybean

Demand

(9) $BD_i = BD_i\,(MS_i, OS_i, PB_i)$

Supply

(10) $BDM_j = BDM_j\,(MS_j, OS_j, PB_i, PB_j)$

(11) $BS_i = BS_i\,(PB_i, \alpha_\iota)$

III. Soybean export price determination

(12) $PBS = \Sigma(BS_i/BS)PB_i$

(13) $PMS = \Sigma(MS_i/MS)PMS_i$

(14) $POS = \Sigma(OS_i/OS)POS_i$

(15) $PB_j = PBS\,(1 + T_j)$

IV. Trade restrictions & equi. conditions

(16) $PMS_i = PMS\,(1 + M_j)$

(17) $POS_j = POS\,(1 + O_j)$

(18) $MD_j = MS_j$

(19) $OD_j = OS_j$

(20) $BS_i = BD_i + \Sigma(BDM_j)$

(21) $MS_i = \Sigma MDM_j$

(22) $OS_i = \Sigma ODM_j$

Table 2. Variables and Their Definitions in the Model (in the sequence of the equations)

Variable	Definition
MD_j	demand for domestic soymeal in country j
PMD_j	domestic soymeal price in country j
PMM_j	soymeal import price in country j
OD_j	demand for domestic soyoil in country j
POD_j	domestic soyoil price in country j
POM_j	soyoil import price in country j
MM_j	import demand for soymeal in country j
OM_j	import demand for soyoil in country j
PB_j	soybean price in country j
PB_i	soybean price in country i
PMS_i	export supply price of soymeal from country i
POS_i	export supply price of soyoil from country i
BD_i	demand for soybean in country i
MS_i	domestic supply of soymeal in country i
OS_i	domestic supply of soyoil in country i
BDM_j	import demand for soybean in country j
MS_j	domestic supply of soymeal in country j
OS_j	domestic supply of soyoil in country j
BS_i	soybean supply in country i
PBS	world soybean export supply price
BS	world total soybean supply
PMS	world soymeal export supply price
MS	world total soymeal supply
POS	world soyoil export supply price
OS	world total soyoil supply
T_j, M_j, O_j	trade restriction variables in country j for all products
MDM_j	import demand for soymeal in country j from country i
ODM_j	import demand for soyoil in country j from country i
α_i	soybean export supply shifter in country i

3.3. Equilibrium Displacement Model

To investigate the impacts on soybean industry sectors of exogenous shocks in different country groups, the total differential of each equation in the model was taken and was expressed in the form of relative changes ($\partial x / x = EX$) and elasticities which is known as the equilibrium displacement model (EDM):

I. Soybean joint products

<u>Consumption</u> <u>Production</u>

(1) $EMD_j = \eta_j^M EPMD_j + \eta_j^M{'} EPMM_j$

(2) $EOD_j = \eta_j^O EPOD_j + \eta_j^O{'} EPOM_j$

(3) $EMM_j = \varepsilon_j^M EPMD_j + \varepsilon_j^M{'} EPMD_j$

(4) $EOM_j = \varepsilon_j^O EPOD_j + \varepsilon_j^O{'} EPOM_j$

(5) $EPMD_j = cs_j^M EPB_j + \sum cs_i^M EPB_i$

(6) $EPOD_j = cs_j^O EPB_j + \sum cs_i^O EPB_i$

(7) $EPMS_i = cs_i^M EPB_i$

(8) $EPOS_i = cs_i^O EPB_i$

II. Soybean

Demand

(9) $EBD_i = os_i^M EMS_i + os_i^O EOS_i + \gamma_i^B EPB_i$

(10) $EBDM_j = os_j^M EMS_j + os_j^O EOS_j + \theta_j EPB_j + \sum \theta_i EPB_i$

Supply

(11) $EBS_i = \delta_i EPB_i + \partial \alpha_i$

III. Soybean export price determination

(12) $EPBS = \sum \pi_i^B EPB_i$

(13) $EPMS = \sum \pi_i^M EPMS_i$

(14) $EPOS = \sum \pi_i^O EPOS_i$

IV. Trade restrictions & equi. conditions

(15) $EPB_j = EPBS + T_j/(1 + T_j)ET_j$

(16) $EPMM_j = EPMS + M_j/(1 + M_j)EM_j$

(17) $EPOM_j = EPOS + O_j/(1 + O_j)EO_j$

(18) $EMD_j = EMS_j$

(19) $EOD_j = EOS_j$

(20) $EBS_i = \varphi_i^B EBD_i + \sum \varphi_j^B EBDM_j$

(21) $EMS_i = \sum \varphi_j^M EMM_j$

(22) $EOS_i = \sum \varphi_j^O EOM_j$

where η is the own-price elasticity of domestic demand for soybean joint product (M = meal and O = oil), η' is the cross-price elasticity of domestic demand for soybean joint product, ε is the cross-price elasticity of import demand for soybean joint product, ε' is the own-price elasticity of import demand for soybean joint product, *cs* is the cost share, *os* is output share, γ price elasticity of input demand, θ is elasticity of input demand from domestic and non-domestic sources, δ is the soybean supply elasticity, π is the soybean export market share, and φ is the market share of demand for exports of soybean and its joint products.

3.4. Parameter Values Specification

In an EDM, the accuracy of parameters has direct impact on the simulation results. Assuming that they are known with certainty is a drawback of EDM because with this practice, the values might be biased in order to generate desired results. As developed by Davis and Espinoza, this study extends the common practice by imposing certain probability distributions for selected parameters in the model instead of adopting only one value for them to generate stochastic estimates for endogenous variables. The definition, value, and sources for the elasticities are presented in Table 3. The cost, output, and market shares were estimated with data obtained from PS&D/USDA, Companhia Brasileira de Abastecimento (CONAB), and Secretaria Argentina de Pecuaria y Agricultura (SAGPyA).[5]

[5] Shares estimations are available upon request.

Table 3. Elasticities: Definition, Value, and Source.

Item	Value	Source
<u>Soymeal domestic demand</u>		
Own-price elasticity (η)		
- Asia	~ GRKS (-0.60, -0.38, -0.20)	(1)
- EU	~ GRKS (-0.16, -0.10, -0.04)	(1)
Cross-price elasticity (η')		
- Asia	0.14	Author
- EU	0.23	Author
<u>Soyoil domestic demand</u>		
Own-price elasticity (η)		
- Asia	~ GRKS (-0.54, -0.33, -0.20)	(1)
- EU	-0.07	(1)
Cross-price elasticity (η')		
- Asia	0.036	Author
- EU	0.024	Author
<u>Soymeal import demand</u>		
Cross-price elasticity (ε)		
- Asia	~ GRKS (0.77,0.80,0.82)	Author
- EU	0.045	Author
Own-price elasticity (ε')		
- Asia	-0.01	Author
- EU	-0.64	Author
<u>Soyoil import demand</u>		
Cross-price elasticity (ε)		
- Asia	1.88	Author
- EU	~ GRKS (0.22,0.39,0.49)	Author
Own-price elasticity (ε')		
- Asia	-0.06	Author
- EU	-0.31	Author
<u>Soybean demand</u>		
Own-price elasticity (γ)		
- Brazil	-0.10	(2)
- U.S.	~ GRKS (-0.87,-0.44,-0.16)	(1), (3), and (4)
- Argentina	~ GRKS (-0.40,-0.37,-0.34)	(2) and (3)
Input demand from j sources (θ)		
- Asia	~ GRKS (0.28,0.34,0.40)	Author
- EU	0.02	Author
Input demand from i sources (θ)		
Asia		
- Brazil	-0.15	Author
- U.S.	-0.12	Author
- Argentina	-0.15	Author
EU		
- Brazil	-0.015	Author
- U.S.	-0.031	Author

Table 3. Continued.

- Argentina	-0.017	Author
Soybean supply		
Own-price elasticity (δ)		
- Brazil	~ GRKS (0.20,0.43,0.55)	(1) and (5)
- U.S.	~ GRKS (0.14,0.55,0.87)	(1) and (3)
- Argentina	~ GRKS (0.03,0.28,0.60)	(1), (2), and (3)

(1) Piggott et al. (2) Fuller et al. (3) Qaim and Traxler. (4) Mattson et al. (5) Williams and Thompson.

4. Scenarios and Results

Scenario 1: Reduction in transportation costs due to improvement in infrastructure in Brazil.

After the reduction in transportation costs was introduced into the model, the SEDM was solved and results for selected variables were analyzed.

Table 4. Scenario 1: 15 % Reduction in transportation costs in Brazil

Importers	%-change*
EBDM - AS: Asia Imp. Demand for Soybean	(0.011,0.022)
EMM - AS: Asia Imp. Demand for Soymeal	(-0.031,-0.027)
EOM - AS: Asia Imp. Demand for Soyoil	(-0.016,-0.014)
EBDM - EU: EU Imp. Demand for Soybean	(0.001,0.009)
EMM - EU: EU Imp. Demand for Soymeal	(0.006,0.007)
EOM - EU: EU Imp. Demand for Soyoil	(-0.007,-0.002)
Exporters	
EBS - BR: Brazil Soybean Supply	(0.058,0.066)
EBS - US: U.S. Soybean Supply	(-0.001,0.001)
EBS - AG: Argentina Soybean Supply	(0.0001,0.002)
EMS - BR: Brazil Soymeal Supply	(0.003,0.004)
EMS - US: U.S. Soymeal Supply	(-0.007,-0.006)
EMS - AG: Argentina Soymeal Supply	(0.0011,0.0015)
EOS - BR: Brazil Soyoil Supply	(-0.0035,-0.0029)
EOS - US: U.S. Soyoil Supply	(-0.001,-0.0008)
EOS - AG: Argentina Soyoil Supply	(-0.0044,-0.0038)
EPB - BR: Brazil Soybean Export Price	(-0.1901,-0.1671)
EPB - US: U.S. Soybean Export Price	(-0.002,0.001)
EPB - AG: Argentina Soybean Export Price	(0.003,0.008)
EPMS - BR: Brazil Soymeal Exp. Supply Price	(-0.063,-0.055)
EPMS - US: U.S. Soymeal Exp. Supply Price	(-0.001,0.001)
EPMS - AG: Argentina Soymeal Exp. Supply Price	(0.001,0.003)
EPOS - BR: Brazil Soyoil Exp. Supply Price	(-0.041,-0.036)
EPOS - US: U.S. Soyoil Exp. Supply Price	(-0.0004,0.0001)
EPOS - AG: Argentina Soyoil Exp. Supply Price	(0.001,0.002)

* 95% probability interval.

In respect to the oilseed, for Brazil, the results suggested an increase in soybean supply between 5.8 and 6.6 percent. Such increase in supply might explain the decrease in soybean price, which is between 16 and 19 percents. Brazil will, very likely, become more export competitive compared to the U.S. and Argentina. In addition, these three countries were insignificantly affected, having almost no change in the soybean price and supply. For the importing countries, both Asia and EU had an increase in soybean imports, with Asia having a larger effect than EU. This increase in soybean imports from Asia and EU might be generated by Brazil's increase in supply and less expensive soybean.

For the soybean joint products, the results displayed opposite effects on soymeal supply (increase between 0.3 and 0.4 percent) and soyoil supply (decrease between 0.29 and 0.35) in Brazil. Furthermore, the effect for soymeal and soyoil almost cancel out each other and the net impact approximates zero. Significant changes were observed for soymeal and soyoil export prices. Brazilian soymeal and soyoil export price decreased and the intervals are (5.5, 6.3) percent and (3.6, 4.1) percent, respectively. A possible explanation for such reduction is that less costly oilseeds are used as an input for domestic processing, which will enhance the competitiveness of Brazil in soybean joint products market. For the importing countries, only Asia had significant decrease in soymeal and soyoil imports.

Scenario 2: Reduction in transportation costs due to improvement in infrastructure in Brazil and decrease in LDP subsidy in the U.S.

A 5 percent decrease in U.S. LDP rate was incorporated in the model simultaneously with Scenario 1. Selected results are shown in Table 5.

Table 5. Scenario 2: 5% Reduction of the LDP subsidy program by the U.S. and 15 % Reduction in transportation costs in Brazil

Importers	%-change*
EBDM - AS: Asia Imp. Demand for Soybean	(0.006, 0.016)
EMM - AS: Asia Imp. Demand for Soymeal	(-0.019, 0.012)
EOM - AS: Asia Imp. Demand for Soyoil	(-0.009, 0.007)
EBDM - EU: EU Imp. Demand for Soybean	(-0.0001, 0.0066)
EMM - EU: EU Imp. Demand for Soymeal	(0.002, 0.006)
EOM - EU: EU Imp. Demand for Soyoil	(-0.006, -0.001)
Exporters	
EBS - BR: Brazil Soybean Supply	(0.057, 0.066)
EBS - US: U.S. Soybean Supply	(-0.031, -0.005)
EBS - AG: Argentina Soybean Supply	(0.001, 0.003)
EMS - BR: Brazil Soymeal Supply	(0.0037, 0.0051)
EMS - US: U.S. Soymeal Supply	(-0.001, 0.014)
EMS - AG: Argentina Soymeal Supply	(0.003, 0.007)
EOS - BR: Brazil Soyoil Supply	(-0.001, 0.004)
EOS - US: U.S. Soyoil Supply	(0.0002, 0.0034)
EOS - AG: Argentina Soyoil Supply	(-0.002, 0.004)
EPB - BR: Brazil Soybean Export Price	(-0.191, -0.168)
EPB - US: U.S. Soybean Export Price	(0.042, 0.146)
EPB - AG: Argentina Soybean Export Price	(0.004, 0.012)
EPMS - BR: Brazil Soymeal Exp. Supply Price	(-0.063, -0.056)
EPMS - US: U.S. Soymeal Exp. Supply Price	(0.018, 0.065)
EPMS - AG: Argentina Soymeal Exp. Supply Price	(0.002, 0.005)
EPOS - BR: Brazil Soyoil Exp. Supply Price	(-0.041, -0.036)
EPOS - US: U.S. Soyoil Exp. Supply Price	(0.010, 0.037)
EPOS - AG: Argentina Soyoil Exp. Supply Price	(0.001, 0.003)

* 95% probability interval.

Under this scenario, Brazil's oilseed supply increases with the interval between 5.7 and 6.6 percent. This put a downward pressure in the Brazilian soybean export price, which induces a decrease between 16.8 and 19.1 percent. Such decrease in price enables Brazil to gain market share from U.S. and Argentina, and consequently become more competitive. The 5 percent reduction in U.S. LDP will make the U.S. less competitive in the exporting market because, as was shown, U.S. soybean export price increase between

4.2 and 14.6 percent. In addition, U.S. soybean supply also dropped and the decrease was between 0.5 and 3.1 percent, which was caused by the reduction in subsidies. For the importing countries, Asia and EU had an increase in soybean imports between 0.6 and 1.6 percent, which can be explained by the lower price of Brazil's soybean. EU also had an increase in imports, but it is not significant as Asia's increase.

The model suggests opposite effects in respect to supply for soymeal and soyoil by Brazil. As for the competing exporting countries supply, U.S. and Argentina had insignificant change percentage-wise. U.S. soymeal and soyoil export prices increased between (1.8, 6.5) percent and (1.0, 3.7) percent, respectively. Because the soybean and soymeal/oil are jointly linked markets, the more costly the input (oilseed) is, the more expensive the output (soymeal and soyoil) becomes. For the importing countries, both Asia and EU have ambiguous intervals for both joint products.

5. Conclusions

This study assessed changes in soybean and its joint products in terms of trade volume, demand and supply, and price under two different scenarios. First, an export cost competitiveness comparison between the major exporting countries was analyzed. With respect to internal transportation costs, it showed that Brazil has a 63.22 percent disadvantage compared to the U.S. Therefore, scenario one analyzed a possible reduction in transportation costs through improvement in infrastructure in Brazil. The other scenario incorporated a reduction in U.S. LDP rate. A stochastic equilibrium model (SEDM) was developed and solved by incorporating self estimated parameters into these two scenarios. Six groups of countries were classified according their international trade status in soybean and joint products and were divided into exporting and importing countries. The results were consistent with the impacts examined by the qualitative framework on the basis of modern international trade theory.

In the first scenario, the reduction in transportation costs boosts Brazil's soybean supply and, consequently, the soybean export price drops. The soybean export price decrease makes Brazil more competitive in the world market and leads to an increase in imports by Asia and EU. The soybean joint products sector for Brazil had diverging results. Soymeal supply increased meanwhile soyoil supply decreased. Brazilian soymeal and soyoil export prices decreased, which indicates that less costly input (oilseed) made output (soymeal and soyoil) cheaper. For the other exporting countries, the changes in supply and export price for soymeal and soyoil were insignificant.

By introducing a subsidy reduction in the U.S., for the oilseed, the second scenario shows noticeable difference for the U.S. compare to scenario one. With respect to the U.S., the 5 percent decrease in LDP rate causes a supply decrease and export price increase. This combination makes the U.S. less competitive in the oilseed global market. For the soybean joint products, Brazil soymeal supply increases meanwhile but soyoil supply decreases. Brazil export price for the derived products goes up, which it is not an optimistic indicator as it dampens the export competitiveness of Brazil. On the other hand, U.S. soymeal and soyoil export prices increased, implying a loss in competitiveness. Argentina is the country which might be benefited from the policy change in U.S. Both Asia and EU have ambiguous intervals for soymeal and soyoil.

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