Estimation of Market Power in the U.S. Soybean Export Markets

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Abstract

Soybean exports are crucial for the survival of the U.S. soybean industry. Price flexibilities of the U.S. reversed residual supply functions were used to test the market power in U.S. soybean export markets. Results indicated that the market power of the U.S. soybean export market is highly sensitive to the U.S. exporters' transaction costs.

Introduction & Research Objectives

In the U.S., the value of soybean production was $16.18 billion in 2002/2003, ranking second among all agricultural bulk commodities behind corn (USDA-ERS, 2004). Since 2000, soybean is the leading agricultural bulk commodity exported from the U.S. (Figure 1) (USDA-FAS, 2004). From a global perspective, the U.S. is also the leading country in soybean exports (Figure 2). In 2002, U.S. soybean exports were 27.43 million metric tons, accounting for 50 % of the world soybean exports (FAO, 2004).

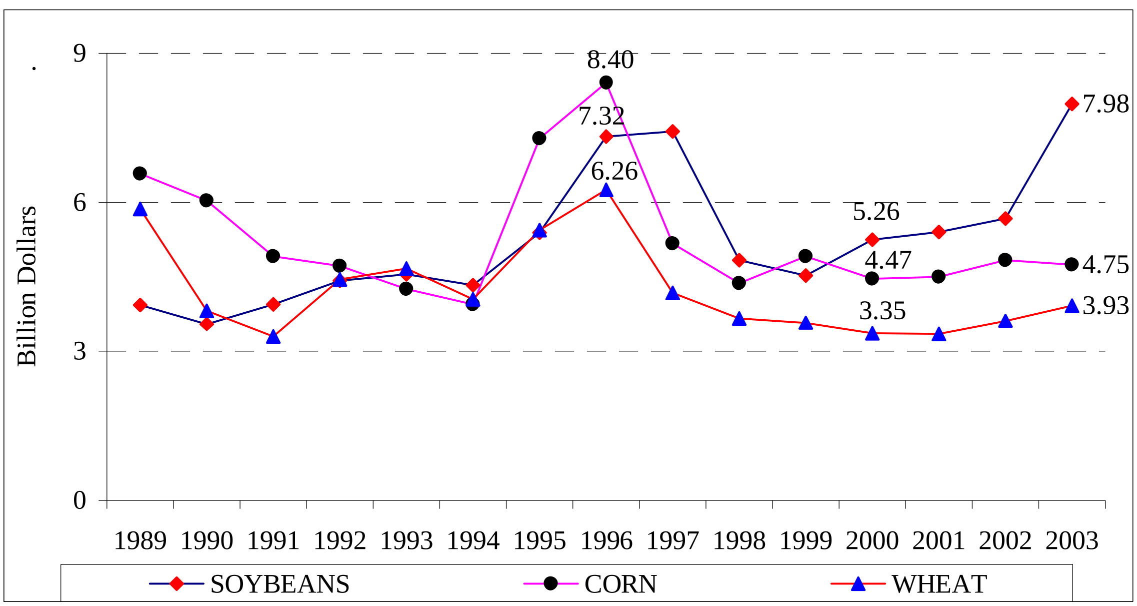

Figure 1. U.S. Leading Export Agricultural Bulk Commodities.

In 2003, soybeans exported from the U.S. accounted for 36 % of the total soybeans produced in U.S. Therefore, the export market is crucial to the survival of the U.S. soybean industry. Main U.S. soybean export markets are the European Union (EU), China (CH), Mexico (MX), and Japan (JP). In 2002, the import shares of U.S. soybeans for the European Union, China, Mexico, and Japan are 21.61 %, 17.56 %, 14.16 %, and 13.55 % respectively (USDA-FAS, 2004). Trends of U.S. soybean exports to the European Union, China, Mexico, and Japan are shown in figure 3. The European Union's share of U.S. soybean exports is declining while trends for China and Mexico are increasing. The average growth rate of China's soybean imports from the U.S. was 127% in the last decade (1992-2002). Japan's soybean imports from the U.S. were relatively stable.

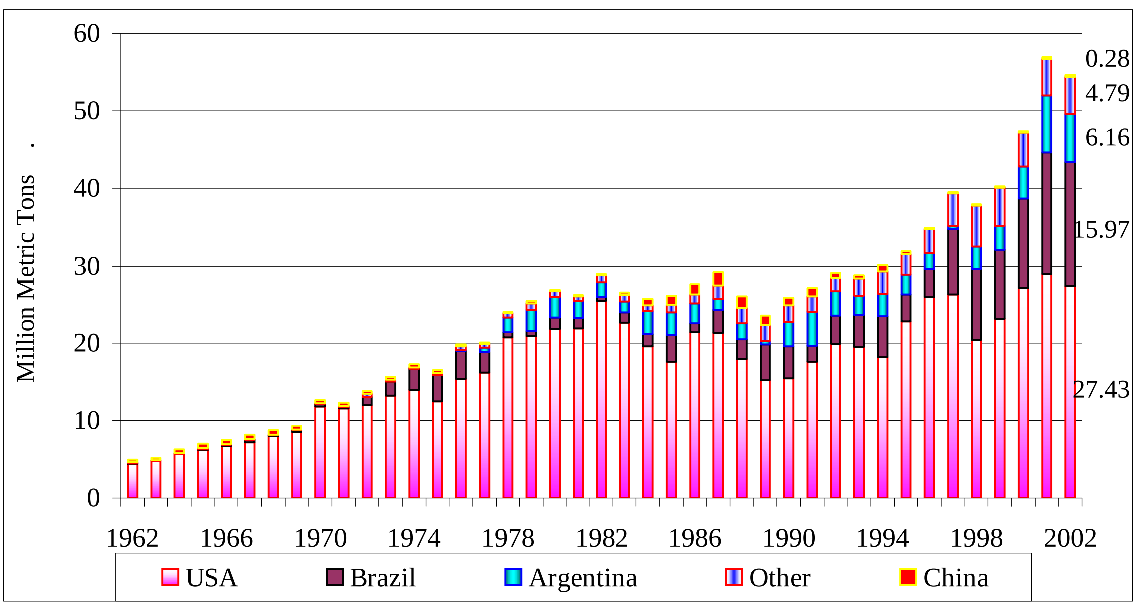

Figure 2. Soybean Export Comparison.

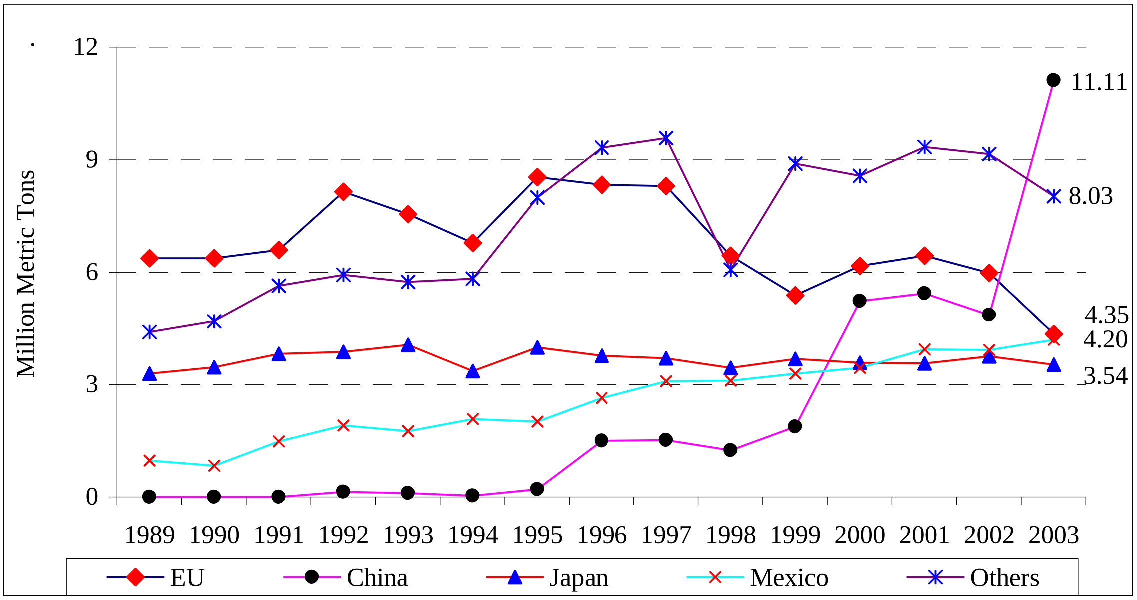

Figure 3. Main U.S. Soybean Export Markets.

Theoretically, it can be hypothesized that the four main importers—EU, China, Japan, and Mexico—have some degree of monopsony power in the U.S. soybean export markets. The objective of this paper is to use price flexibilities of the U.S. reversed residual supply functions to test the market power of the four U.S. soybean importers.

Abbott and Kallio (1996) reviewed the development of the New Trade Theory and its contributors to the literature in detail. They compared the different approaches used in the application of game theory in international agricultural commodity markets. Empirical studies were mainly focused on the test of market power in world agricultural product markets. Summary of previous empirical research on market power in world agricultural product markets can be found in Carter and MacLaren's work (1997). Carter and MacLaren modified the new empirical industrial organization (NEIO) model by incorporating product differentiation in the model. Hypothesizing simulated game scenarios on the Japanese beef market, they concluded that it does matter for an empirical analysis whether an oligopolistic market is characterized by price-setting or quantity-setting behavior.

Golderberg and Knetter (1999) developed the residual demand elasticity model to estimate the market power of German beer exports and U.S linerboard exports. They reported strong evidence of imperfect competition in the Australian market for U.S linerboard exports. Carter et al. (1999), based on Goderberg and Knetter's framework, examined the Japanese wheat market and found no compelling evidence of imperfect competition contradicting the results from Dixit and Josling (1997).

Derivation of the Adjusted Lerner Index

Following Carter et al (1999), it is assumed that each country is an aggregated firm. The estimated parameters can be interpreted as the share-weighted industry averages for all the exporters in the United States. In addition, it is assumed that the exported soybeans are homogeneous. Importer *i* will choose import quantity Q_i to maximize its import profits.

$$(1)\quad \underset{Q_i^{Exp}}{\mathrm{Max}}\ \pi_i = \frac{P_i^D}{ER_i} * Q_i^{EXP} - [P_i^{EXP}(Q_i^{EXP}) + C_i] * Q_i^{EXP}$$

i={EU, CH, MX, JP, the Rest of the World (ROW)}

where P_i^D is the domestic soybean price in the importing country *i*, ER_i is the exchange rate of country *i*, Q_i^{EXP} is the quantity of soybeans exported from the U.S. to country *i*. P_i^{EXP} is the U.S. export price to country *i*, C_i is average transaction costs of country *i* and it is assumed constant in this model. Then, solving for the first order condition gives:

$$(2)\quad \frac{\frac{P_i^D}{ER_i} - [P_i^{EXP} + C_i]}{P_i^{EXP}} = \frac{dP_i^{EXP}}{dQ_i^{EXP}} * \frac{Q_i^{EXP}}{P_i^{EXP}}$$

The left hand side of equation (2) is defined as the Adjusted Lerner Index (*ALI*), which measures the import price margin for country ***i***. The right hand side is the price flexibility of the U.S. reversed residual supply for country ***i***. By estimating the price flexibility of the U.S. reversed residual supply for country ***i*** we can measure country ***i***'s market power. If the estimated price flexibility is equal to or less than zero for country ***i*** then country ***i*** has no market power. If the estimated price flexibility is a positive number for country ***i*** then country ***i*** has a certain degree of monopsony power.

Derivation of the Model

U.S. soybean exporters will choose different export quantity combinations to maximize their export profits:

$$(3)\quad \underset{Q_i^{Exp}}{\text{Max}}\ \pi = \sum_i P_i^{Exp}(Q_i^{Exp}) * Q_i^{Exp} \ - (P_{US}^{Farm} + C_{US})\sum_i Q_i^{Exp}$$

Differentiating equation (3) with respect to the export quantity *Qi* gives the following first order condition:

$$(4)\quad \begin{aligned} \frac{\partial p}{\partial Q_i^{Exp}} &= \left(\frac{\partial P_i^{Exp}}{\partial Q_i^{Exp}} * Q_i^{Exp} + P_i^{Exp}\right) + \sum_{j\neq i}\left(\frac{\partial P_j^{Exp}}{\partial Q_j^{Exp}} * \frac{\partial Q_j^{Exp}}{\partial Q_i^{Exp}} * Q_j^{Exp} + P_j^{Exp} * \frac{\partial Q_j^{Exp}}{\partial Q_i^{Exp}}\right) \\ &- \left(P_{US}^{Farm} + C_{US}\right)\left[1 + \sum_{j\neq i}\frac{\partial Q_j^{Exp}}{\partial Q_i^{Exp}}\right] = 0 \end{aligned}$$

Rearranging equation (4) gives

$$(5)\quad P_i^{Exp} = \left[(1 + \sum_{j\neq i} q_{ji})/(q_i + 1)\right] * \left(P_{US}^{Farm} + C_{US}\right) - \sum_{j\neq i}\left[\frac{(q_j + 1)q_{ji}}{(q_i + 1)}\right] * P_j^{Exp},$$

where $q_i = \frac{\partial P_i^{Exp}}{\partial Q_i^{Exp}} * \frac{Q_i^{Exp}}{P_i^{Exp}}$, since the variable ROW includes many countries, it is reasonable to assume that the monopsony power of the rest of the world is zero, i.e. $q_{ROW} = 0$; $q_{ji} = \frac{\partial Q_j^{Exp}}{\partial Q_i^{Exp}}$, the terms q_{ji} can be explained as the U.S. strategic quantity adjustment between the different export markets.

Assuming transaction costs C_{US} are a constant portion (a) of the U.S. soybean farm level price P_{US}^{Farm}, equation (5) can be written as:

$$(6) \quad P_i^{Exp} = \frac{(1+a)}{(q_i+1)} * (1+\sum_{j\neq i} q_{ji}) P_{US}^{Farm} - \frac{1}{(q_i+1)} \sum_{j\neq i} \left[(q_j+1) q_{ji} P_j^{Exp} \right]$$

Equation (6) is a five equation system indexed by *i*, where *i=EU, CH, MX, JP*, and *ROW*.

Data

Data used are monthly observations from October 1995 to December 2003. Quantity and value of soybeans exported from the U.S. were obtained from USDA-FAS. Export prices of soybeans were obtained by dividing the export value by quantity exported. U.S. soybean farm level prices were obtained from USDA-NASS. For the term $q_{ji} = \frac{\partial Q_j^{Exp}}{\partial Q_i^{Exp}}$, this quotient, $\frac{(Q_j^{Exp}{}_t) - (Q_j^{Exp}{}_{t-1})}{(Q_i^{Exp}{}_t) - (Q_i^{Exp}{}_{t-1})}$, was used to approximate q_{ji}.

Empirical Results

Full information maximum likelihood was used to estimate the nonlinear equation system. Since the U.S. exporter’s transaction costs have an important impact on the estimation of market power, the model was estimated under 4 different scenarios: α=0.18, α=0.15, α=0.12, and α=0.10. Since $\frac{(Q_{j\ t}^{Exp}) - (Q_{j\ t-1}^{Exp})}{(Q_{i\ t}^{Exp}) - (Q_{i\ t-1}^{Exp})}$ was used to approximate $q_{ji} = \frac{\partial Q_j^{Exp}}{\partial Q_i^{Exp}}$. Observations with consecutive zero values made the denominator zero and were automatically deleted by SAS. The estimation results are reported in the following table.

Table 1. Estimation Results Obtained Using FIML Estimator Under Different Transaction costs Scenarios.

Cost (α)	Parameter	Estimate	Approx Std Err	t Value	Approx Pr > |t|
α=0.18	θeu	0.0573***	0.0030	19.15	<.0001
	θch	0.0619***	0.0044	14.22	<.0001
	θjp	0.0483***	0.0057	8.41	<.0001
	θmx	0.0137***	0.0054	2.57	0.0124
α=0.15	θeu	0.0339***	0.0025	13.38	<.0001
	θch	0.0332***	0.0038	8.81	<.0001
	θjp	0.0322***	0.0045	7.17	<.0001
	θmx	-0.0136	0.0037	-3.68	0.0005
α=0.12	θeu	0.0128***	0.0022	5.93	<.0001
	θch	0.0022	0.0031	0.72	0.474
	θjp	0.0168***	0.0036	4.69	<.0001
	θmx	-0.0424	0.0029	-14.8	<.0001
α=0.10	θeu	0.0006	0.0021	0.26	0.7924
	θch	-0.0201	0.0027	-7.4	<.0001
	θjp	0.0052*	0.0031	1.69	0.0956
	θmx	-0.0639	0.0027	-23.92	<.0001

* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.

Results given above suggest that the market power is highly sensitive to transaction costs of U.S. soybean exporters. Under the assumption that U.S. soybean exporters' transaction costs (taken as the percentage of the U.S. soybean farm level price) are 0.18, all four importers have some degree of monopsony power over U.S. soybean exporters. If U.S. soybean exporters' transaction costs are 0.15, Mexico loses its monopsony power, while the European Union, China, and Japan still have some degree of monopsony power. When U.S. soybean exporters' transaction costs are 0.12, China and Mexico lose their monopsony power, and finally if U.S. soybean exporters' transaction costs are 0.10, all four main importers lose their monopsony power.

Conclusions

This research, based on the Adjusted Lerner Index, estimated price flexibilities of the U.S. reversed residual supply functions to measure the market power of different importers of U.S. soybeans. To obtain estimated price flexibilities, this paper developed a nonlinear-equation system through the first order condition of U.S. soybean exporters' profit maximization problem. The results show that the market power of U.S. soybean export markets is very sensitive to U.S. soybean exporters' transaction costs. If U.S. soybean exporters' transaction costs are equal to or greater than 18% of the U.S. farm level price, then all four main importers—EU, China, Japan, and Mexico—have some degree of monopsony power. If U.S. soybean exporters' transaction costs are below 10%, then all four main importers will lose their monopsony power. Results support policies for significant cost reduction measures for U.S. soybean exporters. From a public policy perspective the results support the export incentive programs for U.S. soybean exporters.

References:

Abbott, Philip C. and Panu K.S. Kallio. "Implications of Game Theory for International Agricultural Trade." *Amer. J. Agr. Econ.* 78 (1996): 738-744.

Carter, Colin A. and Donald MacLaren, "Price or Quantity Competition? Oligopolistic Structures in International Commodity Markets," *Review of International Economics* 5 (August 1997), 373-385.

Carter,C.A., D. MacLaren, and A. Yilmaz. "How Competitive is the World Wheat Market". Working Paper No. 99-002, July 1999, Department of Agricultural and Resource Economics, University of California Davis.

Dixit, Praveen M. and Timothy E. Josling, "State Trading in Agriculture: An Analytical Framework," International Agricultural Trade Research Consortium, Working Paper No. 97-4, Minneapolis (July 1997).

Food and Agricultural Organization (FAO) of United Nation. "FAOSTAT database." Website: http://apps.fao.org/page/collections. Accessed in January 2004.

Goldberg, Pinelopi K. and Michael M. Knetter, "Measuring the Intensity of Competition in Export Markets," *Journal of International Economics* 47 (February 1999), 27-60.

U.S. Department of Agriculture, Economic Research Service (USDA-ERS). Data (Online), 2004. Website: http://www.ers.usda.gov/Data/.

U.S. Department of Agriculture, Foreign Agriculture Service (USDA-FAS). U.S. Trade Internet System (Online), 2004. Website: http://www.fas.usda.gov/ustrade/

U.S. Department of Agriculture, National Agricultural Statistics Service (USDA-NASS). Agricultural Statistics Data Base (Online), 2004. Website: http://www.nass.usda.gov:81/ipedb/