Export Market Pricing Decisions and Market Power in World Grain Markets: A Duopoly Model for Soybeans

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Abstract

This study investigates export pricing decisions and market power for soybeans using a duopoly model. The results from the pricing-to-market approach and residual demand elasticity approach show the soybean export markets are competitive. The continuous increase in world demand results in a positive relationship between export prices and volumes.

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Introduction

Imperfect competition is an obvious potential characteristic of world grain markets. Small numbers of countries dominate export shares or import shares for every individual grain in the world market. In the soybean export market, the U.S., Brazil and Argentina are the major exporting countries, accounting for nearly 90% of total world market. The U.S. and Brazil alone account for more than 70% of world exports. Many studies have focused on estimating the existence and magnitude of market power for these oligopolistic markets from either the exporters' perspective or the importers' perspective.

From the exporters' perspective, this study employs a non-cooperative duopoly model to analyze world soybean market. To measure the existence and magnitude of market power for soybeans and to investigate the export pricing decisions for the duopolists, two basic models, the pricing-to-market (PTM) and residual demand elasticities approach (RDE) will be modified for use in this study. In most grain markets, transactions are denominated in a common currency (U.S. dollar), however, currency devaluation in Brazil raised the farm price in local currency and boosted soybean plantings in Brazil which decreasing world price. It is necessary to study the effect of the value of the U.S. competitor's currency on the exporters' pricing decision. The specific objectives of the study are: 1) to investigate the evidence of pricing to market by U.S. and Brazilian exporters in international soybean markets through a modified PTM model; 2) to investigate the impacts of some determinants (e.g., the value of the U.S. dollar and its volatility relative to the importer's currency, the value of Brazil's currency per dollar and some importer's demand shifters) on export pricing decisions for both countries' exporters; 3) to test the extent of market power through calculating the elasticity of the inverse residual demand function for the U.S. and Brazil. Based on bilateral data between exporters and importers, a pooled cross section-time series model will be applied to analyze the market structures for these two models.

Literature Review

Studies in General Economics

In industrial organization theory, the traditional method to measure market power is the Lerner index, which is the relative mark-up of price over marginal cost. Furthermore, prior to the 1980s, many empirical analyses on market power and U.S. antitrust policy were dominated by the structure-conduct-performance (SCP) paradigm, which uses related performance to measure an industry's structure. However, these methods have been criticized for a long time due to data and conceptual problems (Fisher and McGowan, 1983). It is difficult to measure the actual marginal cost to calculate Lerner index and accounting data are not appropriate to measure marginal cost (Goldberg and Knetter, 1999).

Research about market structure is an important issue in the new trade theory literature. Krugman's (1987) hypothesis about pricing-to-market (PTM) is based on the analyses that an exporter with market power can keep its destination-specific import price unchanged or raise (lower) it when an importer's currency appreciates (depreciate) relative to the exporter's currency. He argues that exporters have power to exercise a form of third-degree price discrimination (charging different prices in different markets) across their destinations. This influential idea presents a basic approach for examining market power and imperfect competition. Moreover, Knetter's (1989, 1993) empirical specification, by using pooled cross-sectional, time series data to study the price discrimination by U.S. and German exporters, can distinguish the conditions between a perfectly competitive market and an imperfectly competitive market by using his empirical model. This model has been employed and modified for many industries. The advantage of the PTM method is its simplicity of specification and interpretation. Through comparing the coefficient of the exchange rate variable, this method can detect differences in pricing behavior among exporters.

Currently, studies on the market power hypothesis in international trade have adopted the residual demand elasticity (RDE) approach under the new empirical industrial organization (NEIO) framework. This methodology was first developed by Baker and Bresnahan (1988). Goldberg and Knetter (1999) applied the RDE model to measure the extent of international competition in the German beer and U.S. kraft paper industries. This method estimates the market power of a producer by considering the supplies of other producers and the measuring the inverse elasticities of residual demand function of that producer. The advantage of this method is that it can measure the magnitude of market power and explicitly identify the relationship between the export price and volumes.

Studies in Agricultural Economics

The PTM method has been employed by many empirical studies in agricultural products during the last decade (e.g. Knetter, 1989 and 1993; Pick and Park, 1991; Pick and Cater, 1994; Abbot, Patterson, and Reca, 1993; Saghaian and Reed, 2004). Pick and Park (1991) apply the PTM model to examine U.S. exports of wheat, corn, cotton, soybean, and soybean meal and oil from 1978 to 1988, but they find the U.S. firms have no practiced price discrimination across destination markets for cotton, corn, and soybeans. Pick and Carter (1994) employed the PTM model to investigate the wheat market with transactions denominated in a common currency (U.S. dollar). In their research, a duopoly market structure involving the U.S. and Canada is assumed in wheat, and they investigate the effects of changes in the exchange rate between U.S. and Canadian dollars on both U.S. and Canadian wheat exports. They also confirm the evidence of PTM for both American and Canadian exporters.

For the RDE model, Carter et al. (1999) examine the Japanese wheat market and find that the import market for wheat in Japan is imperfectly competitive. Glauben and Loy (2003) employ both the PTM and RDE models to analyze imperfect competition for German food and beverage exporters in major international markets. They found that some results from the PTM and RDE models are not consistent. Silvente (2004) also applies the PTM and RDE models to the ceramic title industry for Italy and Spain.

In this study, more variables that will influence the exporting price, such as the third-country's exchange rate (Brazilian Real per U.S. dollar) effect and the demand shifters, will be incorporated into the model for grain market analysis. According to the characteristics of the world grain market, a modified PTM model with more variables is needed for the study. This study also adopts the RDE model to test market power for export and checks the validity of the results by comparing the two approaches.

Model

Pricing-To-Market (PTM) Model

Following the basic model used by Pick and Carter (1994), consider the world's two largest soybeans exporters: The U.S. and Brazil. Together they account for over 70% of world exports, so a U.S.-Brazil duopoly model will be employed in this study. It is reasonable to assume that every exporting country is a firm (Carter et. al, 1999). As mentioned in the first essay, it is reasonable to assume that all soybean transactions in world grain market are denominated in U.S. dollars.

The U.S. leads the world in agricultural biotechnology. Since 1996 U.S. farmers have adopted genetically modified (GM) soybeans widely. According to the USDA-ERS, the GM soybeans account for 89% of total U.S. soybeans production. At one time, Brazil banned the use of GM varieties. After GM varieties were authorized in Brazil, one third of Brazilian soybean production has been genetically modified. Almost all the soybeans (98%) planted in Argentina are GM varieties. When GM soybeans were not permitted in Brazil, according to a USDA-ERS publication in 2000, the soybean price was the most important factor in determining global market share and the production of biotech soybeans was not a key factor for market share of U.S. soybeans. Moreover, with the increase in the percentage of GM soybeans planted in Brazil, any important differences in soybean quality have gradually weakened across exporting countries in the world soybeans trade. So it is reasonable to assume that the U.S. and Brazilian soybeans are homogenous.

Suppose $q_{j,i}(e_{us,i}p_{j,i}, \sigma_{us,i}, Z_i)$ is importing country i's (i =1,…., n) demand for exports from exporting country j (j = U.S., Brazil in this study), $P_{j,i}$ is the price of the grain measured in U.S. dollars and $e_{us,i}$ is the exchange rate between the U.S. and the i^{th} importing country. $e_{us,i}p_{j,i}$ is the soybean price in the importing market currency, $\sigma_{us,i}$ is the exchange rate volatility between the U.S. dollar and exporting country's currency, and Z_i is a vector of demand shifters on the importing market (e.g., income, lagged price). For the soybean case, i =1,…., n, and j = U.S., Brazil. The profit maximization problem for the U.S. and Brazilian firms can be modeled as

$$(1)\quad Max\,\pi_{us} = \sum_i^n p_{us,i}q_{us,i}(e_{us,i}p_{us,i}, e_{us,i}p_{br,i}, \sigma_{us,i}, Z_i) - C_{us}(\sum_i^n q_{us,i}, W^{us})$$

$$(2)\quad Max\,\pi_{br} = \sum_i^n e_{br}p_{br,i}q_{br,i}(e_{us,i}p_{br,i}, e_{us,i}p_{us,i}, \sigma_{us,i}, Z_i) - C_{br}(\sum_i^n q_{br,i}, W^{br})$$

Where, e_{br} is Brazilian currency per U.S. dollar, C is the cost function of the exporter, which depends on the exporting quantities and other cost shifters (W^{us}, W^{br}), and both $P_{us,i}$ and $P_{br,i}$ are denominated in U.S. dollars. Differentiating (1) and (2) with respect to $P_{us,i}$ and $P_{br,i}$ for the first order conditions:

$$(3)\quad \frac{\partial \pi_{us}}{\partial p_{us,i}} = p_{us,i}\frac{\partial q_{us,i}}{\partial p_{us,i}} + q_{us,i} - \frac{\partial C_{us}}{\partial q_{us,i}}\frac{\partial q_{us,i}}{\partial p_{us,i}} = 0$$

(4) $$\frac{\partial \pi_{br}}{\partial p_{br,i}} = e_{br}[p_{br,i}\frac{\partial q_{br,i}}{\partial p_{br,i}} + q_{br,i}] - \frac{\partial C_{br}}{\partial q_{br,i}}\frac{\partial q_{br,i}}{\partial p_{br,i}} = 0$$

Solving (3) and (4), the two exporting countries' reaction functions can be obtained as:

(5) $$p_{us,i} = R_{us,i}(p_{br,i}, e_{us,i}, e_{br}, \sigma_{us,i}, Z_i, MC_{us})$$

(6) $$p_{br,i} = R_{br,i}(p_{us,i}, e_{us,i}, e_{br}, \sigma_{us,i}, Z_i, MC_{br})$$

Differentiating (5) and (6) with respect to the exchange rate, e_{br} and $e_{us,i}$, respectively, one obtains

the effects of exchange rate changes on export prices:

(7) $$\frac{\partial p_{us,i}}{\partial e_{us,i}} = \frac{\partial R_{us,i}}{\partial p_{br,i}}\frac{\partial p_{br,i}}{\partial e_{us,i}} + \frac{\partial R_{us,i}}{\partial e_{us,i}} + \frac{\partial R_{us,i}}{\partial \sigma_{us,i}}\frac{\partial \sigma_{us,i}}{\partial e_{us,i}} + \frac{\partial R_{us,i}}{\partial Z_i}\frac{\partial Z_i}{\partial e_{us,i}} + \frac{\partial R_{us,i}}{\partial MC_{us}}\frac{\partial MC_{us}}{\partial e_{us,i}}$$

(8) $$\frac{\partial p_{br,i}}{\partial e_{us,i}} = \frac{\partial R_{br,i}}{\partial p_{us,i}}\frac{\partial p_{us,i}}{\partial e_{us,i}} + \frac{\partial R_{br,i}}{\partial e_{us,i}} + \frac{\partial R_{br,i}}{\partial \sigma_{us,i}}\frac{\partial \sigma_{us,i}}{\partial e_{us,i}} + \frac{\partial R_{br,i}}{\partial Z_i}\frac{\partial Z_i}{\partial e_{us,i}} + \frac{\partial R_{br,i}}{\partial MC_{br}}\frac{\partial MC_{br}}{\partial e_{us,i}}$$

(9) $$\frac{\partial p_{us,i}}{\partial e_{br}} = \frac{\partial R_{us,i}}{\partial p_{br,i}}\frac{\partial p_{br,i}}{\partial e_{br}} + \frac{\partial R_{us,i}}{\partial e_{br}} + \frac{\partial R_{us,i}}{\partial MC_{us}}\frac{\partial MC_{us}}{\partial e_{br}}$$

(10) $$\frac{\partial p_{br,i}}{\partial e_{br}} = \frac{\partial R_{br,i}}{\partial p_{us,i}}\frac{\partial p_{us,i}}{\partial e_{br}} + \frac{\partial R_{br,i}}{\partial e_{br}} + \frac{\partial R_{br,i}}{\partial MC_{br}}\frac{\partial MC_{br}}{\partial e_{br}}$$

Equations (7) and (8) explain the effects of foreign exchange rate change between the U.S. dollar and other importing country's currency on U.S. and Brazilian export prices. On the right hand side, the first term shows how the U.S. exporter reacts to the change in the competitor's export price, which is from the change in the exchange rate between the U.S. dollar and the importing country's currency. The second term shows the direct reaction of the U.S. exporter to the change in the foreign exchange rate. The third, the forth, and the last terms represent how the U.S. exporter reacts to changes in exchange volatility, import demand shifters, and marginal cost of production, respectively which result from the change of the exchange rate between the U.S. dollar and other importing country's currency. Equations (9) and (10) demonstrate similar impacts of the changes in the exchange rate between the U.S. and Brazilian currency on exporting price, even though U.S. dollars are used in soybean trade. It is obvious that the U.S. soybeans exporter's pricing decisions are impacted by the exchange rate, exchange rate volatility, third-country effects (Brazilian real per U.S. dollar), marginal cost of production, and other importing countries' demand shifters. The effects of the above variables on U.S. and Brazilian soybean exporters need to be identified in the empirical study.

In Knetter's (1989, 1993) pricing-to-market model, he describes the price discrimination-markup relationship from solving the profit maximization problem and using the inverse elasticity rule. He finds that the export price to each importing country is the product of the marginal cost and a destination-specific markup: (11) $p_{it} = MC_t(\frac{\eta_{it}}{\eta_{it}-1})$,

Where $i = 1,..., N$; $t = 1,..., T$ p_{it} is the export price to importing country i, MC_t is the marginal cost of production in period t, and η_{it} is the price elasticity of demand in importing country i. In order to identify the exporter's pricing-to-market behavior, Knetter uses a fixed-effects model applied to time series-cross sectional data. The basic model is: (12) $\ln(p_{it}) = \theta_t + \lambda_i + \beta_i \ln(e_{it}) + u_{it}$

Where θ_t is a dummy variable for time effects, (e.g., measuring marginal cost), λ_i is a dummy variable for the importing country effect, $\ln(e_{it})$ is the natural log of the real exchange rate, and u_{it} is the disturbance term. Three different market structures are discussed by Goldberg and Knetter. In a perfectly competitive market, price and marginal cost are equal and export prices are the same for every destination country. Therefore, no country effect exists (λ_i =0) and no relationship between exchange rate changes and price changes occurs (β_i =0). Under an imperfectly competitive market, when price discrimination occurs with constant price elasticities of demand, there is country effect ($\lambda_i \neq 0$) but no exchange rate effect (β_i =0). When $\beta_i \neq 0$, the market is segmented and the constant price elasticities of demand hypothesis can be rejected.

Some studies extend this basic empirical model through involving either more relevant variables or employing other statistic methods. Saghaian and Reed (2001) modify Knetter's (1989) pooled cross section-time series model to investigate the market structure of U.S. meat export markets. They use domestic wholesale prices to substitute for the time-related dummy variables to measure marginal costs and involve lagged export price in the model. Glauben and Loy (2003) use the importing country's real GDP in their research model for estimating the PTM behavior of German food exporters. Tantirigama (2003) includes the competitors' price and market share in the destination market to investigate agricultural exports in New Zealand. For empirical methods, most studies use a fixed or random effects panel data analysis model. Saghaian and Reed and Glauben and Loy (2003) employ the seemingly unrelated regression model to consider the potential correlations of residuals across equations.

For the PTM method, this study will employ a time series-cross sectional regression model for both exporters:

(13) $$\ln(p_{i,t}) = \lambda_i + \beta_i \ln(e_{us,i,t}) + \gamma_i \ln(\sigma_{i,t}) + \delta_i \ln e_{br,t} + \theta_t \ln(fp_t) + \rho_i \ln(pl_{i,t}) + \varphi_i \ln(GDP_{i,t}) + u_{i,t}$$

In this specific model, p_{it} is the export price in U.S. dollars to market i in period t; λ_i is the country effect; $e_{us,i,t}$ is the importing country's currency per U.S. dollar and $\sigma_{i,t}$ is its volatility; $e_{br,t}$ is the Brazilian currency per U.S. dollar; fp_t is the soybean price received by U.S. soybean producers instead of time-related dummy variables. This farm level price is more appropriate to measure the marginal cost comparing with the time-related dummy variables. Due to the unavailability of Brazilian farm level price, the U.S.'s farm level price is used to Brazilian model; $pl_{i,t}$ is the lagged export price to investigate price transmission from the exporting market to the export destination. $GDP_{i,t}$ is per capita GDP for market i in period t.

Residual Demand Elasticity (RDE) Model

Another new method to investigate market power is the residual demand elasticity approach, which is developed by Baker and Bresnahan (1988), and Goldberg and Knetter (1999). Specifically, following the above assumptions for world soybeans market, it is reasonable to assume that the U.S. and Brazil both face an inverse residual demand function. The related inverse demand curve for the U.S. or Brazil is downward sloping and is the difference between market demand and supplies of its competitors. The residual demand for the U.S. and Brazilian firms can be modeled as

(14) $P^{us} = P^{us}(Q^{us}, Q^{br}, Z)$ and (15) $P^{br} = P^{br}(Q^{br}, Q^{us}, Z)$

Where P^{us} and Q^{us} are price and quantity of U.S. soybean exports; P^{br} and Q^{br} are price and quantity of Brazilian soybean exports and Z are exogenous variables entering the demand system.

The differences between the PTM and the RDE models are P^{us} and P^{br} are denominated in the destination market currency. The profit maximization problem for the U.S. and Brazil can be described as:

(16) $Max\pi^{us} = P^{us}(Q^{us}, Q^{br}, Z)Q^{us} - e_{us,i}C^{us}(Q^{us}, W^{us})$

(17) $Max\pi^{br} = P^{br}(Q^{br}, Q^{us}, Z)Q^{br} - e_{us,i}e_{br}C^{br}(Q^{br}, W^{br})$

Where $e_{us,i}$ is the bilateral exchange rate between the U.S. and destination market; e_{br} is the bilateral exchange rate between the U.S. and Brazil; C^{us} and C^{br} represent the costs for the U.S. and Brazil, respectively; W^{us} and W^{br} represent the costs shifters for the U.S. and Brazil, respectively. With transactions denominated in U.S. dollars, the costs in Brazil must be converted to U.S. dollars first and then converted to the destination market currency. Setting the expected marginal revenue equal to marginal cost, the first order condition for profit maximization is:

(18) $e_{us,i} MC^{us}(Q^{us}, W^{us}) = MR^{us}(Q^{us}, Q^{br}, Z)$

(19) $e_{us,i} e_{br} MC^{br}(Q^{br}, W^{br}) = MR^{br}(Q^{br}, Q^{us}, Z)$

Where $MR^{us}(Q^{us}, Q^{br}, Z) = P^{us} + Q^{us}[\frac{\partial P^{us}}{\partial Q^{br}} + (\frac{\partial P^{us}}{\partial Q^{br}})(\frac{\partial Q^{br}}{\partial Q^{us}})]$

$$MR^{br}(Q^{br}, Q^{us}, Z) = P^{br} + Q^{br}[\frac{\partial P^{br}}{\partial Q^{us}} + (\frac{\partial P^{br}}{\partial Q^{us}})(\frac{\partial Q^{us}}{\partial Q^{br}})]$$

The terms in brackets indicate the conduct parameter of the U.S. and Brazil for market equilibrium, respectively, and they determine their strategic decisions simultaneously. Specifically, if these two components are equal to zero, market price is equal to marginal cost, so the market is perfectly competitive. Otherwise, market power exists in the market. The larger the conduct parameter, the more market power over price exists in the market. Substituting equation (15) into equation (19), one obtains equation (20) $Q^{br} = Q^{br}(Q^{us}, Z, e_{us,i} e_{br} W^{br})$, which is the residual demand function for Brazil in this duopoly market. Then substituting equation (20) into equation (14), one obtains the inverse residual demand for U.S.

(21) $P^{us} = P^{us}[Q^{us}, Q^{br}(Q^{us}, Z, e_{us,i} e_{br} W^{br}), Z] = P^{us}(Q^{us}, Z, e_{us,i} e_{br} W^{br})$. Using the same method, it is easy to obtain the inverse residual demand function for Brazil:

(22) $P^{br} = P^{br}[Q^{br}, Q^{us}(Q^{br}, Z, e_{us,i} W^{us}), Z] = P^{br}(Q^{br}, Z, e_{us,i} W^{us})$

The exact specification is followed for the RDE in this study is:

(23) $\ln P_{i,t}^{us} = \alpha_i + \beta_i \ln e_{us,i} + \gamma_i \ln \sigma_{i,t} + \rho_i \ln pl_{i,t} + \omega_i \ln(GDP_{i,t}) + \tilde{\eta}_i \ln \tilde{Q}_{i,t}^{us} + \delta_i \ln e_{br} + \theta_i T + \varepsilon_{mt}$

(24) $\ln P_{i,t}^{br} = \alpha_i + \beta_i \ln e_{us,i} + \gamma_i \ln \sigma_{i,t} + \rho_i \ln pl_{i,t} + \omega_i \ln(GDP_{i,t}) + \tilde{\eta}_i \ln \tilde{Q}_{i,t}^{br} + \theta_i T \varepsilon_{mt}$

In this study, the endogenous variables are unit values of the U.S. and Brazil's exports to the respective destination markets measured in the destination market currency, $P_{i,t}^{us}$ and $P_{i,t}^{br}$. T represents the time trend, $\tilde{Q}_{i,t}^{us}$ and $\tilde{Q}_{i,t}^{br}$ are the instrumented export quantities of the U.S. and Brazil to the destination markets, and all other variables are defined as above. One should remember that the U.S. dollar is the common currency in the world market, and the exchange rate between Brazil and each importing country has no effect on trade. However, as a part of the cost shifters, the product of $e_{us,i}$ and e_{br} has an effect on U.S trade for the U.S. model. All the exogenous variables in equation (23) and the soybeans futures market price are used as instruments on the quantity of U.S. and Brazil exports.

Data and Source

The data used are based on the U.S monthly value (1000 U.S. dollar) and quantity (1000 MT) of soybean exports to selected destination markets from February 1996 to July 2006 and export prices of soybeans are obtained by dividing the export value by quantity exported. As the main U.S. soybean export markets, China, Japan, Taiwan, South Korea, Indonesia, Thailand, Mexico, the Netherlands, Germany, and Spain are selected for panel data analysis. The data source is the Foreign Agricultural Service (FAS) of the U.S. Department of Agriculture (USDA). Yearly per capital GDP for every destination market is used as the measure of income, which is available from USDA, Economic Research Service (ERS). The monthly data for income (per capital GDP) are derived from yearly data based on its average growth rate and a trial-and-error method. The trail-and-error method is an empirical method of reaching a satisfactory result by trying out various means until error is sufficiently reduced or eliminated. The monthly exchange rates are available from www.economagic.com.

The major soybean markets for Brazil include China, Japan, Taiwan, South Korea, Thailand, the Netherlands, Germany, and Spain. These eight markets are included in the panel data model. The monthly quantity (1000 MT) and unit price of Brazilian soybean exports are obtained from the Brazilian Department of Agriculture (accessed from http://www.aliceweb.desenvolvimento.gov.br). Some of the exporting prices are zeros (no trade happened in these quarters). They are replaced by one to be able to take logarithms in the estimation.

The standard deviation (risk) measure of the exchange rate is by a moving sample standard deviation of percentage exchange rate (Koray and Lanstapes, 1989; Baba et al., 1992; Chowdhury, 1993; Arize et al. 2000; Sun et al., 2002). Mathematically, it can be described as:

(25) $V_t = [\frac{1}{m}\sum_{i=1}^{m}(\ln R_{j,t+i-1} - \ln R_{j,t+i-2})^2]^{1/2}$

Where m is the order of moving average, and R_j represents exchange rate. Empirically, m is specified as 2 in this study for measuring the volatility.

Empirical Results

This study employs the seemingly unrelated regression (SUR) method for the PTM model and three-stage least squares (3SLS) method for the RDE model to consider the potential correlation of residuals between equations. All variables used in this study are based on nominal values.

Table 1 summarizes the country effect, exchange rate and its volatility coefficients, lagged export price coefficient, and Brazilian real per U.S. dollar coefficient for the U.S. and Brazilian equations by using the PTM model. The characteristics of world soybean trade suggest an imperfectly competitive market structure exists. However, these empirical results based on a theoretical duopoly model do not support this imperfectly competitive market structure. These results are consistent with Pick and Park's (1991) findings from the standard Knetter's PTM model in the international soybean market.

Table1 Empirical Results for The PTM Model

	The U.S. Equation					The Brazilian Equation				
Destination	λ	β	γ	ρ	δ	λ	β	γ	ρ	δ
China	-115.25	59.77	0.45*	0.15*	0.72	74.39	-39.22	0.14	-0.07	3.20**
	(-0.92)	(1.06)	(2.37)	(1.76)	(0.50)	(0.70)	(-0.81)	(0.88)	(-0.94)	(2.46)
Japan	-2.32	-0.01	-0.01	0.34***	0.05**	99.54	1.12	0.71**	1.89	1.12
	(-0.72)	(-0.24)	(-1.63)	(6.67)	(2.48)	(0.62)	(0.41)	(2.36)	(0.76)	(1.04)
Taiwan	-0.71	-0.06	-0.01	0.19**	0.02	-76.26**	-1.55	0.18	-3.71**	1.36
	(-0.56)	(-0.34)	(-0.62)	(2.52)	(0.53)	(-2.29)	(-0.37)	(0.94)	(-2.16)	(1.39)
South Korea	10.40	0.10	0.00	-0.05	0.54	-21.92	-1.41	-0.03	-0.43**	-1.36
	(1.06)	(0.15)	(0.00)	(-0.53)	(1.09)	(-1.37)	(-1.26)	(-0.24)	(-2.96)	(-1.64)
Thailand	-15.99	1.07	-0.30	-0.07	-0.07	-9.43	-3.82*	0.41*	-0.05	1.47
	(-1.02)	(0.44)	(-1.13)	(-0.78)	(-0.07)	(-0.66)	(-1.79)	(1.90)	(-0.66)	(1.54)
Indonesia	9.79	-1.01	0.04	0.15	0.62	--	--	--	--	--
	(1.10)	(-1.26)	(0.19)	(1.15)	(0.78)					
Mexico	0.25	0.06	-0.01	0.35***	-0.04	--	--	--	--	--
	(0.77)	(0.44)	(-0.54)	(5.02)	(-1.07)					
Netherlands	62.01**	-0.65	-0.10	0.02	-0.67	29.65	0.66	-0.03	-0.06	2.22**
	(2.05)	(-0.87)	(-0.36)	(0.28)	(-0.70)	(1.08)	(0.97)	(-0.10)	(-0.82)	(2.54)
Germany	161.26***	-0.45	0.01	0.19**	1.03	-53.60	-1.06	0.19	-0.03	-0.23
	(2.68)	(-0.42)	(0.02)	(2.22)	(0.93)	(-1.11)	(-1.28)	(0.69)	(-0.52)	(-0.24)
Spain	57.81***	-0.36*	0.03	0.35***	0.25	-38.56**	0.20	-0.13	-0.07	-0.09
	(2.97)	(-1.96)	(0.07)	(4.67)	(0.23)	(-2.67)	(1.54)	(-0.56)	(-1.32)	(-0.11)
System weighted R-square: 0.76						System weighted R-square: 0.15				

Note: Values in parentheses are t-values. One asterisk denotes significance at the 10% level, two asterisks denote significance at the 5% level, and three asterisks denote significance at the 1% level.

In the U.S. equation, there are no significant country effects or significant exchange rate effects exist for Asian export destinations and Mexico. These results suggest that markets are integrated across Asian export destinations and Mexico. For the EU countries, the Netherlands and Germany have significant coefficients for the country effects only. Only Spain has significant coefficients for the exchange rate variable and the country effect. According to Knetter's model, the significant relationship between export price and the bilateral exchange rate implies the rejection of the constant elasticity condition in the Spanish market, and the negative coefficient shows the exporters adjust export prices to offset the exchange rate movements. In the case of China, the coefficient of exchange rate is extremely high and it does not reflect the real elasticity because of China's fixed exchange rate before August, 2005 (the exchange rate can be considered as a constant before August, 2005). However, as the largest importing country in world soybean market, China is involved in the model in order to keep the integrity of the empirical study. The bilateral exchange rate volatility has no significant effect on the export pricing decision for the U.S.'s soybean exporters.

More than half (six of ten) of the coefficients of the lagged price are statistically significant. The large explanatory role of the lagged price indicates that it takes more than one period for export price to adjust the changes of economic conditions. Overall, the exchange rate between the U.S. and Brazil is not an important variable in the export pricing decision of the U.S. exporter.

In the Brazilian equation, the system weighted R-squared is only 15 percent. Only two of ten country effects and one of ten bilateral exchange rate coefficients are significant. The results do not support the hypothesis that Brazil as a duopolist in the soybean export market engaged in the price discriminating behavior in the world soybean market. Two of ten coefficients for bilateral exchange rate volatility and exchange rate between the U.S. and Brazil are statistically significant, indicating that they do not play significant roles in the export pricing decisions for Brazilian soybean exporters. The results show most of the coefficients for the lagged export prices are not statistically different from zero, indicating prices pass through quickly.

Table 2 summarizes the inverse residual demand elasticities, exchange rate and its volatility coefficients, lagged export price coefficient, and Brazilian real per U.S. dollar coefficient for the U.S. and Brazil by using the RDE model.

Table 2 Empirical Results for the RDE Model

	The U.S. Equation					The Brazilian Equation			
Destination	β	γ	ρ	η	δ	β	γ	ρ	η
China	77.88	0.47**	0.11	0.73***	1.91	-6.70	-0.09	0.03	1.31***
	(1.56)	(2.25)	(1.03)	(6.88)	(0.84)	(-0.18)	(-0.58)	(0.30)	(11.80)
Japan	0.92***	0.00	0.91***	0.04	-0.07	0.97	1.19	2.92	0.80***
	(10.74)	(0.04)	(23.89)	(1.31)	(-1.33)	(0.18)	(1.96)	(1.39)	(4.06)
Taiwan	0.66***	-0.00	0.63***	-0.03**	-0.05	-1.76	-0.02	0.05	1.94***
	(3.09)	(-0.39)	(9.53)	(-2.11)	(-0.91)	(-0.43)	(-0.07)	(0.03)	(13.48)
South Korea	0.79	0.10	-0.13	0.53*	-0.10	1.62	-0.20	-0.01	2.69***
	(0.48)	(0.54)	(-0.69)	(1.83)	(-0.08)	(1.67)	(-1.42)	(-0.07)	(22.38)
Thailand	2.12	-0.58	-0.05	0.52**	-2.10	-2.78	0.02	-0.04	2.36***
	(0.46)	(-1.43)	(-0.39)	(2.50)	(-0.78)	(-1.06)	(0.09)	(-0.56)	(11.93)
Indonesia	-1.55	0.62	0.20	1.41***	1.53	--	--	--	--
	(-0.79)	(1.59)	(1.17)	(4.14)	(0.98)				
Mexico	1.24***	0.00	0.58***	-0.08***	-0.01	--	--	--	--
	(7.20)	(0.13)	(8.26)	(-2.99)	(-0.16)				
Netherlands	0.07	-0.12	-0.02	0.20**	-1.41	0.47	0.04	-0.04	0.63***
	(0.09)	(-0.40)	(-0.24)	(2.48)	(1.20)	(0.78)	(0.17)	(-0.60)	(6.13)
Germany	1.21	-0.03	0.28***	0.30**	0.80	0.73	-0.01	0.03	0.96***
	(0.90)	(-0.08)	(2.93)	(2.64)	(0.65)	(1.04)	(-0.06)	(0.52)	(10.61)
Spain	0.45***	-0.11	0.51***	1.19***	-1.80	0.89***	-0.13	0.07	1.31***
	(2.77)	(-0.31)	(5.58)	(7.48)	(-1.60)	(6.44)	(-0.45)	(0.73)	(7.57)
System weighted R-square: 0.6						System weighted R-square: 0.5			

Note: Values in parentheses are t-values. One asterisk denotes significance at the 10% level, two asterisks denote significance at the 5% level, and three asterisks denote significance at the 1% level.

In the U.S. equation, all the coefficients of the instrumented quantities are statistically significant. However, only two of them have the expected negative sign. The absolute values of the coefficients of quantity for Taiwan and Mexico, which are significantly different from zero and with the expected sign, approximate the mark-up over marginal cost. It might mean there is some power in these two markets. For other export destinations, more quantity is forthcoming if the price is higher. There may not be market power in these markets. Four of ten coefficients of the exchange rate are statistically significant. The exchange rate volatility and Brazilian real per U.S. dollar are not important to explain the export price denominated in the destination market currency.

In the Brazilian equation, the system weighted R-square is 50 percent. Overall, the exchange rate and its volatility, the exchange rate between Brazil real and U.S. dollar, and the lagged export price do not play the important roles in explaining the export price. For the coefficients of instrumented export volumes, they have similar conditions with the U.S. model. All the coefficients are positively significant. Again, there is no evidence of market power in these markets.

It is necessary to analyze the potential causes for the positive inverse residual demand elasticities for the U.S. and Brazilian equations. Overall, the soybean export demand is strong in the world. The major factor influencing the growing demand for soybean has been a global increase in meat consumption based on the increase of per capita GDP, especially the tremendous increase in Chinese soybean consumption. Global soybean production has kept up with this increase in consumption; hence the positive relationship. For both the U.S. and Brazil, the soybean production has climbed steadily while the domestic soybean consumption has been relatively stable. The U.S. dominance of global soybean markets has been eroded by its competitors from South America, but U.S.'s exports have steadily increased. For Brazil, its soybean export volumes and global market share have increased rapidly over the past decade. The Brazilian real depreciation raised the farm price in local currency and boosted the soybean planting. On the other hand, the impacts of currency depreciation on imported inputs have been reduced by pricing most inputs in terms of bags of soybeans (USDA report, 2001). So there is no significant effect of Brazilian real per U.S. dollar on export pricing decision in the empirical results. Both soybean supply and demand increase continually, and the basic conclusions from the empirical results are that the demand changes are leading to increased supplies in the world soybean market.

Furthermore, the world soybean price peaked at around $10/bu in 2003/2004 when low production in both the U.S. and South America occurred while global demand continued to increase, but the export volumes did not decrease in this period. Higher prices get soybeans out of storage and away from domestic consumption into export markets. The extremely higher price doesn't occur for long periods of time, and soybean increases soon to meet the increased demand. Thus, the soybean price has generally been at a relatively low level over the last decade. Furthermore, a relatively higher price in this period doesn't seem to stem the increase in demand for soybeans that is coming from other demand factors. This empirical study is based on the shorn-run (monthly) data. In the short-run, if the soybean supply is considered unchanged, the import demand decides the price. The continuous increase in world soybean demand drives the export price up and it results in a positive relationship between export prices and export volumes in the RDE model.

Summary and Conclusion

The U.S. and Brazil are the two most important soybean exporters in the world. This study attempts to investigate the export pricing decisions and market power in major international markets for these duopolists based on two empirical models: the modified PTM approach and RDE approach. For the PTM approach, a SUR method is applied to the panel data analysis. The results reject the hypothesis that the soybean export pricing decisions for both the U.S. and Brazilian exporters are consistent with price discrimination across the destination markets. The results show that bilateral exchange rate and its volatility and the changes of Brazilian real per U.S. dollar have no significant effect on export price.

The PTM approach heavily focuses on the relationship between the exchange rate and price reactions. It does not explicitly explain the relationship between export price and export volumes. The RDE approach which tests the inverse residual demand elasticity for every destination market based on the 3SLS method is applied in this study. The results are not consistent with economic theory and most of the coefficients on quantity exported are positively significant. There is no market power exerted in these markets. In the short-run, if the supply has no big changes, continuous increases in world demand result in a positive relationship between soybean export price and export volumes for both countries.

It is clear for this study that soybean export markets are competitive and integrated among destinations and the emergence of Brazil has made it even more so. These findings contribute to the literature on trade policy and domestic support issues for soybean sector. Soybean exports are relatively unhindered by global tariffs and both the U.S. and Brazil have no market power on export markets. Because of the continuous increase in world demand under a competitive global market, the best strategy for the U.S. is to enhance soybean yields and quality, improve soybean cost advantages, and expand new soybean uses. This will improve the U.S position relative to Brazil.

Further research is definitely needed in this area based on the findings of this paper. Supply and demand adjustments in importing markets certainly influence world trade and prices and they are not included in this analysis. This study assumes that soybeans are homogeneous. Relaxing this hypothesis and considering the importing markets' preferences for non-GM soybeans are needed. Moreover, a study of the demand by major importing markets and monopsony power measures should be investigated. A more structured economic system which involve both supply factors and demand factors will provide more rigorous results on pricing and export volumes.

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