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Market Power of Genetically Modified Soybeans Traded Between the United States and Korea

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Abstract

Purpose – The purpose of this study was to investigate market power of soybeans exported by the United States to Korea. Particularly, this paper considered dichotomous characteristics of genetically modified (GM) soybeans and non-GM soybeans and conducted empirical analysis of these two segregated soybean markets to understand key tenets of market power in international soybean trade.
Design/methodology – The difference in market power between GM and non-GM soybeans was analyzed using Residual Demand Elasticity (RDE) and Residual Supply Elasticity (RSE) models over the period of 2008~2018. RDE and RSE models under an imperfect competition condition were used to estimate market margins and determine whether GM and non-GM exporters or importers exercised market power in the destination market.
Findings – Empirical results suggested that the U.S. had a market power on both GM and non-GM soybean exports. GM exports had greater market power than non-GM exports (14% vs. 9%). By contrast, Korea showed an inability to grab market margin or exert market power in soybean imports. Both export supply by the U.S. and import demand by Korea were found to be more responsive to price changes of GM soybeans than to prices changes of non-GM soybeans. This might be due to a self-interested, profit-seeking strategy by the exporter and many concerned consumers regarding potential adverse effects of GMOs in the importing country.
Originality/value – This paper fills the literature gap by exploiting market power in both GM and non-GM markets with explicit consideration of price correlations between GM and non-GM soybeans in Korea. A number of existing studies have provided evidence for market power broadly embedded in international commodity trade. However, studies focusing on Korean markets are limited. No study has explored the country's soybean trade. Furthermore, the majority of prior studies have almost exclusively focused on the market power from a standpoint of exporting countries without discussing importers' market structure. This paper also sought to understand potentially distinguished patterns of market power between GM and non-GM markets.

Keywords: Genetically Modified Soybeans, Market Power, Residual Demand Elasticity Model, Residual Supply Elasticity Model
JEL Classifications: D43, F14, Q17

1. Introduction

Genetically modified (GM) crops were first commercialized in 1996. Since then, their cultivated areas in the world had steadily increased to 2,339 million hectares in 2017 (ISAAA, 2017), with a market revenue of GM crops and seeds at US$ 17.2 billion in the same year. Principal countries that produce GM crops include the U.S., Brazil, Argentina, Canada, and India, accounting for over 90% of global total areas. Major GM crops are soybean, corn,

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cotton, alfalfa, canola, and some fruits and vegetables. What is noticeable in the U.S. is that GM grains and oilseeds have an overwhelmingly large proportion. For example, in 2018, GM soybean, GM corn, and GM cotton accounted for 94%, 92%, and 94% of their total production, respectively (USDA, 2018).

The wide spread of GM crops, especially in leading exporting countries, offers much food-for-thought from a perspective of importing countries that raise concern for food security, biodiversity conservation, and environmental sustainability (Alonso, Cockx and Swinnen, 2018). GM foods may fall short of meeting food preferences for "all people" (Aheto et al., 2013; World Food Summit, 1996).

With a high dependency on soybean imports from major GM exporters including the U.S. and Brazil, Korea faces a difficult task of securing stable supply of the pulse while satisfying perceived safety from non-GM, food-use soybean imports. More specifically, Korea imported an average of 1.2 million tons of food-use soybeans between 2008 and 2017, of which non-GM soybeans accounted for a quarter of the total (KBCH, 2018).

According to the Ministry of Food and Drug Safety (MFDS) in Korea, the U.S. was the biggest exporter to Korea, with 631,000 tons in 2017. Of these, non-GM soybeans account for 37% (234,000 tons). The second biggest exporter to Korea is Brazil which focuses on GM soybean exports. Over the period of 2008-2017, China accounted for about 30% of non-GM soybean imports (Ji Seong-Tae and Lee Su-Hwan, 2019; Rhee Hyun-Jae, 2019).

These statistics indicate the top two foreign suppliers of GM soybeans (Brazil and the U.S.) and non-GM soybeans (the U.S. and China) can exercise strong market power, with dominant shares of 92% and 96%, respectively. Economic theory points out that such an oligopolistic supplier might have an incentive to increase prices by limiting the quantity exported. It will be interesting to find out whether Korea is exploiting its market power as a significant buyer.

A mandatory labeling requirement for GMOs that contain 3% or higher of GMOs has been designed to provide information to consumers (NFSIS, 2014). Recent public request for the so-called "complete" labeling measure of GM products regardless of gene detectability represents the prevailing anti-GMO sentiment in the country.

Against a backdrop of Korea's soybean trade, the objective of this study was to explore the market power of soybean trade between the U.S. and Korea. A difference in market power between GM and non-GM soybeans was analyzed by Residual Demand Elasticity (RDE) and Residual Supply Elasticity (RSE) models over the period of 2008~2018. RDE and RSE models structured under an imperfect competition condition can estimate market margins and test if the exporter or the importer exercises market power in the destination market.

A number of existing studies have examined and provided evidence for market power broadly embedded in international commodity trade. However, research on Korean markets remains limited. Up to date, no study has reported the country's soybean trade. Furthermore, the majority of prior studies have almost exclusively focused on market power from a standpoint of exporting countries while importers' market structure is not discussed.

To fill this literature gap, the objective of this study was to conduct empirical analysis to understand key tenets of market power in international soybean trade in two segregated soybean markets (i.e., GM and non-GM markets) in Korea. Another objective of this study was to understand potentially distinguished patterns of market power between GM and non-GM markets.

2. Literature Review

Table 1 summaries selected studies of market power applied to various commodities across countries. Since the first application of the RDE model by Baker and Bresnahan (1988), this approach has been widely used to identify the existence of market power and traders' behavior. The fact that the exporter market power is more commonly discovered indicates the world grain market is highly concentrated. It can be categorized as a "thin" market. Nevertheless, the exercise of market power by importers is also a reason of concern because of its anti-competitive exclusion (Kim Yong-Yul and Lee Jong-Won, 2009).

Based on the model of Baker and Bresnahan (1988), an early study of Goldberg and Knetter (1999) has shown market power of exporters in destination country without firm-specific sources. Their article also suggested a nominal exchange rate as a relevant cost shifter of competing exporters in the market. Country-based market power analysis has also been explored by Carter, MacLarean and Yilmaz (1999) with each country as a single firm. Estimated parameters of the RDE model in the double-log form can be considered as a share-weighted industry average for all firms in a particular country.

The study of Yang Seung-Ryong and Lee Won-Jin (2001) is the first study of its kind that has measured exporters' market power of wheat and corn in the Korean markets by adopting RDE models. Their study found a market power in the wheat import market. In line with the idea of using exchange rate as a real cost shifter of export competitors, Cho Gue-Dae, Jin Hyun-Joung and Koo Won-Whe (2002) have suggested a real exchange rate rather than a nominal one to take account of potential impacts of discretionary monetary policy by countries. Their study also found that U.S. wheat exporters demonstrated large market margins in Korea.

Pertaining to four main beef exporters to Japan, Reed and Saghaian (2004) have included a time trend in their RDE model and presented different levels of market margins by exporters of beef product. The time trend variable was adopted to address a nonstationary problem arising from autocorrelation in their time series data. Advantages of an RDE model were reported in the study of Poosiripinyo and Reed (2005) in comparison with other measurements, including Structure-Performance-Paradigm, Lerner Index, and Pricing-To-Market. These advantages include modest data requirements, eligibility of estimating elasticities, and ability to use exchange rate as a proxy for marginal cost change.

Another line of research measuring market power from a perspective of importing countries was firstly presented by Song Baohui (2006). In that paper, a two-country partial equilibrium RSE model was used. It provided evidence that Chinese importers had a stronger market power than U.S. exporters in soybean trade. Andersen, Asche and Roll (2008) have explored a system consisting of RDE and RSE equations for dried salted cod and regressed it with the three-stage least-squares (3SLS) method. Estimated elasticities presented both oligopolistic and oligopsonistic behaviors of Norwegian exporters and Portugal importers.

On the other hand, it has been postulated that as GM products are becoming increasingly concentrated, their market power in supply chains has been realized over time. This means that the symmetrical structure of non-GM products is likely to cause a change in the degree of market power. However, this has been previously assessed only to a very limited extent. For example, Mulik and Crespi (2011) only observed that the introduction of GM rice reduced Indian exporters' market margins in U.K. and Kuwait markets.

Yamaura Koichi (2011) has proposed to estimate RDE and RSE models for non-GM soybean trade in Japan and the U.S. with a 3SLS method. However, correlations between GM and non-GM prices was not accounted for in that study. Yamaura Koichi (2012) as well as the current work segregated soybean supply chains into GM and non-GM markets and estimated both RDE and RSE equations with added independent variables for corresponding non-GM and GM soybean prices. While Yamaura Koichi (2012) was constrained to Japanese non-GM soybean markets, the present study extended the scope of exploitation of market power to GM soybeans in Korea and performed a comparative analysis of the two markets' behavior.

Table 1. Studies for Deriving Lerner Index (Market Margins)

Study	Product	Exporter	Importer	Estimate by RDE model	Estimate by RSE model	Estimation method
Goldberg and Knetter (1999)	Beer	Germany	U.S. Canada France U.K.	-0.065 -0.14 -0.44 -0.21		3SLS
Carter, MacLarean and Yilmaz (1999)	Wheat	U.S Canada Australia	Japan	-0.93 *** -0.49 -0.08		2SLS
Yang Seung-Ryong and Lee Won-Jin (2001)	Wheat Corn	U.S Canada Australia U.S. China	Korea	-0.384 ** -0.146 *** -0.142 ** -0.054 -0.032		SUR
Cho Gue-Dae, Jin Hyun-Joung and Koo Won-W. (2002)	Wheat	U.S.	Indonesia Japan Korea Malaysia Philippine Singapore	-0.004 -0.112 -0.614 *** -0.121 *** -0.838 *** -0.160 ***		SUR
Reed and Saghaian (2004)	Beef	Australia Canada New Zealand U.S.	Japan	-0.117 ** -0.171 ** -0.187 *** -0.322 ***		SUR
Poosiripinyo and Reed (2005)	Chicken	Brazil China Thailand U.S.	Japan	-0.253 *** -0.108 -0.081 -0.229 ***		GLS
Song Baohui (2006)	Soybean	U.S.	China	-0.040 ***	0.13 ***	3SLS
Andersen, Asche and Roll(2008)	Dried salted pod	Norway	Portugal	-0.173 ***	0.105 ***	3SLS
Felt, Gervais and Laure (2011)	Pork 1st period	Denmark Canada U.S.	Japan	-0.02 * -0.05 * 0.01		GMM
	2nd period	Denmark Canada U.S.	Japan	-0.01 -0.04 * -0.10 *		
Mulik and Crespi (2011)	Basmati rice 1st period	India	U.S. U.K. Kuwait	1.2% 27.33% 13.84%		3SLS
	2nd period	India	U.S. U.K. Kuwait	2.31% 19.12% 5.69%		

Table 1. (Continued)

Study	Product	Exporter	Importer	Estimate by RDE model	Estimate by RSE model	Estimation method
Yamaura Koichi (2011)	Non-GM soybean	U.S.	Japan	-0.220 *	0.04 *	3SLS
Yamaura Koichi (2012)	Non-GM soybean	U.S.	Japan	-0.330 ***	0.06 ***	3SLS
Pall et al. (2014)	wheat	Russia	Albania Azerbaijan Egypt Georgia Greece Lebanon Mongolia Syria	-0.0883 * -0.1723 -0.0048 -0.0730 * -0.0527 ** -0.0564 -0.2497 -0.0543		IVPPML
Silveira and Resende (2017)	niobium (steel)	Brazil	U.S.	-0.500 ***		2SLS
Uhl and Perekhozhuk (2018)	wheat	Russia	Egypt Turkey	-0.005 -0.135 ***		GMM

Note: *p<0.1, **p<0.05, ***p<0.001.
Source: Yamaura Koichi (2012) and authors' compilation.

3. A Theoretic Framework and Empirical Model Specifications

3.1. A Theoretic Framework

Adoption of RDE and RSE models assumes that the market is under oligopolistic and oligopsony structure, respectively. Residual demand for an exporting firm is expressed as the wedge between the market demand and the supply of other competing firms in the market. The specific firm can realize a positive profit at equilibrium as long as it is able to control the quantity and exercise the power to price. A symmetrical structure is posited for an importing firm's residual supply as the gap between the market supply and the demand by other competing firms. The specific importing firm is able to excise market power by limiting the quantity of imports, leading to an excessive profit.

More formally, Baker and Bresnahan (1988) have laid out three components to derive the residual demand. The first component is the inverse demand for a specific exporting firm 1:

$$P_1 = P_1(Q_1, Q, Z) \tag{1}$$

where P_1 and Q_1 are the price and the quantity for firm 1's product. Q is a vector of quantities from all other competitors. Z is a vector of demand shifters for the firm.

The second component is the inverse demand for all other competing products, Q:

$$P_i = P_i(Q, Q_1, Z) \quad \text{for all } i{\neq}1 \tag{2}$$

where P_i is the price for all other competing products.

The last component refers to supply equations of all other firms where these firms are assumed to maximize their profits given the supply of firm 1. Profit maximization occurs when perceived marginal revenue (PMRi), or the derivative of total revenue equals marginal cost (MCi):

$$eMC_i(Q_i, W, W_i) = PMRi(Q, Q_1, Z; \theta_i) \quad \text{for all } i{\neq}1 \tag{3}$$

where e is the exchange rate between firm i and the importing firm. W is a vector of industry-wide factor prices, affecting all firms. W_i depicts firm i-specific factor prices. θ_i indciates market power of firm i.

Equilibrium quantities for all markets can be derived from equations (2) and (3) as:

$$Q = E_I(Q_1, Z, eW, eW_I; \theta_I) \tag{4}$$

where E_I is the equilibrium quantity for all other markets, i≠1.

Substituting equation (4) into equation (1) forms an inverse demand function for firm 1 as:

$$P_1 = P_1(Q_1, E_I(Q_1, Z, eW, eW_I; \theta_I), Z) \tag{5}$$

When redundant variables are streamlined, equation (5) can be rewritten as:

$$P_1 = D_{res1}(Q_1, Z, eW, eW_I; \theta_I) \tag{6}$$

where the price for firm 1 is expressed as an inverse residual demand function, $D_{res1}(\cdot)$.

As seen in studies of Song Baohui (2006) and Durham and Sexton (1992), one can derive a theoretical RSE model starting from an inverse supply of an input factor or an intermediate good for, say importing firm 2 as:

$$eW_2 = eW_2(Q_2, Q, V) \tag{7}$$

where W_2 is the import price and Q_2 is the import quantity. Q is a vector of import quantities by all other competing importing firms from the same exporting firm and V is a vector of supply shifters.

The inverse supply function for all other firms is specified as:

$$eW_i = eW_i(Q, Q_2, V) \quad \text{for all } i{\neq}2 \tag{8}$$

where W_i denotes import price of inputs for firm i.

The demand schedule for all other importers can be derived from an equilibrium condition where marginal revenue product (MRPi) equals perceived marginal expenditure (PMEi):

$$MRP_i(Q_i, W, P_i) = ePME_i(Q, Q_2, V; \lambda_i) \quad \text{for all } i{\neq}2 \tag{9}$$

where W is a vector of industry-wide factor prices and P_i is firm i-specific sales prices. λ_i indicates market power of firm i.

The residual supply function for all other importers can be derived from equations (8) and (9), solving Q as:

$$Q = E_I(Q_2, eV, eW, P_I; \lambda_I) \tag{10}$$

The residual supply function for importer 2 is obtained by substituting equation (10) into equation (7) as:

$$\mathrm{eW_2 = eW_2(Q_2, E_I(Q_2, eV, eW, P_I;\ \lambda_I), V)} \tag{11}$$

$$\mathrm{eW_2 = S_{res2}(Q_2, eV, eW, P_I;\ \lambda_I)} \tag{12}$$

where the import price for firm 2 is written by an inverse residual supply function $\mathrm{S_{res2}}(\cdot)$.

3.2. Empirical Model Specifications

Taking into account of the theoretical development, this paper sets out empirical equations on certain assumptions. First, tradable soybeans can be grouped as GM and non-GM products in a sense that the market actually differentiates these two types of soybeans. In addition, the traceability of their traits is warrantied. Especially, the mandatory labeling policy and tariff-rate quotas designated only for non-GM food use soybeans make it difficult to treat these two soybeans as like products. Second, despite many firms export or import soybeans, it is assumed that each country has only a single firm. This strong assumption makes one interpret model parameter estimates as share-weighted industry averages for all firms within a country (Carter, MacLarean and Yilmaz, 1999). Lastly, this paper adopts a log-log functional form of empirical models which has been used for estimating elasticities (Goldberg and Knetter, 1999).

Firstly, empirical RDE models for GM and non-GM soybean exports by the U.S. are specified as:

$$\ln P_{US}^{NGM} = \alpha_0 + \alpha_1 \ln Q_{US}^{NGM} + \alpha_2 \ln P_{US}^{GM} + \alpha_3 \ln X_{KR}^{CN} + \alpha_4 \ln Y_{KR} + \varepsilon_{US}^{NGM} \tag{13}$$

$$\ln P_{US}^{GM} = \beta_0 + \beta_1 \ln Q_{US}^{GM} + \beta_2 \ln P_{US}^{NGM} + \beta_3 \ln X_{KR}^{BR} + \beta_4 \ln Y_{KR} + \varepsilon_{US}^{GM} \tag{14}$$

where P_{US}^{NGM} and Q_{US}^{NGM} are the export price and the quantity of non-GM soybeans from the US to Korea. P_{US}^{GM} and Q_{US}^{GM} correspond to those for GM soybeans. X_{KR}^{CN} and X_{KR}^{BR} are exchange rates between Korea and China and between Korea and Brazil, respectively. As cost shifters, these exchange rates embody competing non-GM (China) and GM (Brazil) exporters. The variable Y_{KR} refers to personal disposable income of Korean population, which is counted as a demand shifter. Error terms are ε_{US}^{NGM} and ε_{US}^{GM}.

Parameters of interest with respect to market power are α_1, β_1, α_2 *and* β_2. The estimate of α_1 or β_1 refers to an inverse residual demand elasticity for U.S. non-GM or GM soybeans in Korea. A negative coefficient of α_1 or β_1 indicates that the U.S. has the power to price in non-GM or GM markets. If the coefficient is zero, the US is deemed to face a perfectly elastic demand curve such that it has no power to price in Korea. A larger absolute value of $\widehat{\alpha}_1$ or $\widehat{\beta}_1$ means greater market power.

Parameters α_2 and β_2 depict a demand relationship between non-GM and GM soybeans. A zero value of its estimate suggests that these two types of soybeans are independent of each other. A positive or negative estimate of α_2 and β_2 indicates soybean's characteristics as a substitute or a complement. The size of coefficient estimates corresponds to the strength of the cross relationship.

Secondly, empirical RSE models for GM and non-GM soybean imports by Korea are specified as:

$$\ln P_{KR}^{NGM} = \gamma_0 + \gamma_1 \ln Q_{KR}^{NGM} + \gamma_2 \ln P_{KR}^{GM} + \gamma_3 \ln X_{US}^{CN} + \gamma_4 \ln F_{US} + \varepsilon_{KR}^{NGM} \tag{15}$$

$$\ln P_{KR}^{GM} = \delta_0 + \delta_1 \ln Q_{KR}^{GM} + \delta_2 \ln P_{KR}^{NGM} + \delta_3 \ln X_{US}^{MX} + \delta_4 \ln L_{US} + \varepsilon_{KR}^{GM} \quad (16)$$

where P_{KR}^{NGM} and Q_{KR}^{NGM} are the import price and the quantity of non-GM soybeans exported by the U.S. and P_{KR}^{GM} and Q_{US}^{GM} are counterparts in case of GM soybeans. Exchange rates between China and the U.S. (X_{US}^{CN}) and between Mexico and the U.S. (X_{US}^{MX}) are included to capture cost-competitive relationships. China and Mexico are top importers of the U.S.'s non-GM and GM soybeans, respectively. The variable F_{US} is a soybean-corn future price ratio in the US, factoring in its effect on the U.S.'s spot price and Korea's import price. The variable L_{US} is a monthly average wage rate. Error terms are denoted as ε_{KR}^{NGM} and ε_{KR}^{GM}.

Similar to previous models, estimates of γ_1 *and* δ_1 yield an inverse residual supply elasticity in Korean markets. When these estimates are positive, Korea is supposed to exercise market power. The power to price is nonexistent with a zero value of γ_1 *or* δ_1. Estimates of γ_2 *and* δ_2 can explain the supply relationship between non-GM and GM soybeans. If they are positive, these two types of soybeans appear to be substitutes. If they are negative, they are regarded as complements.

4. Data and Estimation Methods

U.S. soybeans exported to Korea are for food or feed use. This paper only considers food-use soybeans mostly used for processing foods including tofu and cooking oil in Korea. Soybeans are to be declared and labeled as either non-GM or GM crops during import procedures. As such, this paper uses data for quantities and import prices for distinguished soybeans that are documented by Korea's import authority (MFDS).

Data period ranged from January 2008 to April 2018. Weekly data for CIF prices and income were converted to real terms by using Korea's CPI and the US's PPI. Real exchange rates were derived from their purchasing power parity (PPP) values (Krugman and Obstfeld, 2002).

Table 2 provides definitions of model variables and sources of data. Table 3 is a summary of data descriptions.

The Wu-Hausman test in Table 4 finds endogeneity problems with non-GM and GM soybean quantities. Thus, model estimation was carried out with the 2SLS method. Selected instrument variables are U.S. labor cost for Q_{US}^{NGM}, the exchange rate between Mexico and U.S. for Q_{US}^{GM}, the exchange rate between Canada and Korea for Q_{KR}^{NGM}, and Korea's disposable income for Q_{KR}^{GM}. In addition, the Breusch-Pagan-Godfrey test in Table 5 suggests that white heteroskedasticity-consistent standard errors should be used in GM soybean models.

Table 2. Definitions of Variables and Data Sources

Variable	Definition	Source of Data
P	Real CIF export or import prices for non-GM or GM soybeans	Ministry of Food and Drug Safety (MFDS)
Q	Export or import quantity for non-GM or GM soybeans	
X	Real exchange rates	Pacific Exchange Rate Service
Y	Real personal disposable income in Korea	KOSTAT
F	Soybean-corn price ratio	USDA
L	Real labor cost in the U.S.	OECD

Table 3. Summary Statistics of Variables

Variable	Unit	Average	Std. Dev.	Minimum	Maximum
P_{US}^{NGM}	won/ton	888146	1284241	222851	1577292
P_{US}^{GM}	won/ton	539849	77004	432775	729827
Q_{US}^{NGM}	ton	7655	12350	18	53254
Q_{US}^{GM}	ton	42530	20321	1548	104199
X_{KR}^{CN}	yuan/won	.008409	.000992	.006512	.011769
X_{KR}^{BR}	real/won	.002559	.001051	.001264	.004585
Y_{KR}	won	3346665	344150	2686560	3776507
P_{KR}^{NGM}	US$/ton	832	1288	255	1555
P_{KR}^{GM}	US$/ton	504	93	347	719
Q_{KR}^{NGM}	ton	7655	12350	18	53254
Q_{KR}^{GM}	ton	42530	20321	1548	104199
X_{US}^{CN}	yuan/US$	12.45	1.56	10.55	15.62
X_{US}^{MX}	peso/US$	26.77	8.78	15.44	44.42
F_{US}	-	2.31	.3	1.69	2.88
L_{US}	US$	97	7	80	109

Table 4. The Wu-Hausman Test for Endogeneity

H_0: variables are exogenous			
	Models	**Estimate**	**Test Results**
RDE	GM soybean	3.68* (0.0587)	Reject H_0
	Non-GM soybean	6.92** (0.0103)	Reject H_0
RSE	GM soybean	2.89* (0.0932)	Reject H_0
	Non-GM soybean	2.99* (0.0875)	Reject H_0

Note: * and ** indicate 10% and 5% significance levels, respectively. Values in parenthesis are probabilities.

Table 5. The Breusch-Pagan-Godfrey Test for Heteroskedasticity

H_0: there is no heteroskedasticity			
	Models	**Estimate**	**Test Results**
RDE	GM soybean	6.35*** (0.0002)	Reject H_0
	Non-GM soybean	0.25 (0.9072)	Fail to reject H_0
RSE	GM soybean	2.80** (0.0314)	Reject H_0
	Non-GM soybean	1.83 (0.1301)	Fail to reject H_0

Note: *, ** and *** indicate 10%, 5%, and 1% significance levels, respectively. Values in parenthesis are probabilities.

5. Model Estimation Results

Table 6 shows estimated results for RDE models using OLS and 2SLS methods.

Table 6. Estimation Results for RDE Models

Non-GM Soybeans			GM Soybeans		
Variable	**OLS**	**2SLS**	**Variable**	**OLS**	**2SLS**
lnQ_{US}^{NGM}	-0.0226 (0.0249)	-0.0918 ** (0.0444)	lnQ_{US}^{GM}	-0.0258 (0.0172)	-0.1416 * (0.0780)
lnP_{US}^{GM}	0.8557 ** (0.3594)	0.8215 ** (0.3534)	lnP_{US}^{NGM}	0.0684 ** (0.0276)	0.1008 ** (0.0398)
lnX_{KR}^{CN}	-1.7293 *** (0.4915)	-1.0908 * (0.5525)	lnX_{KR}^{BR}	-0.3351 *** (0.0529)	-0.3947 *** (0.0753)
lnY_{KR}	0.5283 (0.4798)	-0.3485 (0.3647)	lnY_{KR}	1.1876 *** (0.2179)	1.5234 *** (0.3442)
Constant	-13.8231 * (7.7789)	3.4541 (8.0828)	Constant	-7.3283 ** (3.3726)	-11.9561 ** (5.1012)
DW	1.8315	2.1735	DW	0.5603	1.4217
R-squared	0.3584	0.3836	R-squared	0.4746	0.1621

Note: *, ** and *** indicate 10%, 5%, and 1% significance levels, respectively. Values in parenthesis are standard errors.

Estimates for export quantity variables were negative and statistically significant, suggesting that the US had market power in their exports of non-GM and GM soybeans in Korean markets. The relatively higher elasticity for GM soybeans with 14% than non-GM soybeans with 9% by the 2SLS estimation might imply that US exporters of the former had more concrete and stronger market establishment in the country (La Jung-Joo and Shin Won-Kyu, 2019).

Coefficients for export prices were positive, implying that GM and non-GM soybeans were substitutes. Their values were less than one, indicating that these two types of soybeans were at most incomplete substitutional goods. A higher coefficient estimate for the export price of GM soybeans suggested that Korea's import demand was relatively sensitive to a change in GM soybean price. This can be in part explained by the prevailing anti-GMO sentiment in the country.

In addition, other variables showed expected signs. They were statistically significant. Real exchange rates find that bilateral soybean trade flows are subject to changes, depending on cost advantages. For example, a strong Korean won against Chinese yuan is likely to trigger import diversion from the U.S. to China in outsourcing non-GM soybeans. Finally, real disposable income in Korea was shown to affect only the export price of GM soybeans.

Table 7 shows estimated results for RSE models using OLS and 2SLS methods.

Quantity variables for Korea turned out to be statistically insignificant in non-GM and GM soybeans. Differently put, Korea was shown to exercise no power to price against US exports, thus taking the price as given. The fact that domestically produced soybeans account for a low market share may partly explain why Korea is small in the trade. Unlike Korea, China and Japan, the largest importers of the U.S. soybeans in the world, are able to mark-down import prices from marginal expenditure by 13% and 4~6%%, respectively (Yamaura Koichi 2011/2012; Song Baohui, 2006).

Table 7. Estimation Results for RSE Models

Non-GM Soybeans			GM Soybeans		
Variable	**OLS**	**2SLS**	**Variable**	**OLS**	**2SLS**
lnQ_{KR}^{NGM}	-0.0335 (0.0248)	-0.0353 (0.0573)	lnQ_{KR}^{GM}	0.0029 (0.0151)	-0.0599 (0.0457)
lnP_{KR}^{GM}	0.3973 (0.3126)	0.7172 * (0.3724)	lnP_{KR}^{NGM}	0.0488 ** (0.0241)	0.0556 ** (0.0232)
lnX_{US}^{CN}	-1.9333 *** (0.4391)	-1.2220 ** (0.5154)	lnX_{US}^{MX}	-0.5439 *** (0.0405)	-0.5585 *** (0.0449)
lnF_{US}	0.2027 (0.3591)	0.3048 (0.6889)	lnL_{US}	1.6367 *** (0.1646)	1.6486 *** (0.2062)
Constant	8.9984 *** (2.8359)	5.1980 * (2.7231)	Constant	0.1346 (0.6598)	0.7486 (0.9640)
DW	1.7729	1.8949	DW	0.4503	0.8053
R-squared	0.3270	0.2808	R-squared	0.7572	0.7060

Note: *, ** and *** indicate 10%, 5%, and 1% significance levels, respectively. Values in parenthesis are standard errors.

Coefficient estimates for import prices by Korea were positive and statistically significant, indicating an imperfect substitution relationship between non-GM and GM soybean supplies. For example, an 1% increase in import price of GM soybeans by Korea would expand its import demand for non-GM soybeans, leading to a 0.72% increase in its import price. A far lower substitutional effect on changes in import prices was found between GM and non-GM soybeans. A higher coefficient estimate for the import price of GM soybeans suggests that U.S. export supplies are relatively sensitive to a change in GM soybean prices. This can be in part explained by a self-interested, profit-seeking strategy by the exporter.

The real exchange rate and the U.S. labor cost are of relevance in explaining Korea's import prices for U.S. soybeans. A strong U.S. dollar against Chinese yuan would curb down U.S. exports to China and instead expand its exports to Korea. A larger supply to the Korean market is likely to lower the import price. Finally, as expected, the U.S. labor cost or wage was shown to function as a significant cost shifter.

6. Conclusions

This paper considered dichotomous characteristics of non-GM and GM soybeans in the Korean market and revealed that the U.S. had market power while Korea did not have it. A greater power to price in GM soybeans compared to non-GM soybeans sheds light on how solid representation and reputation have been established by U.S. exporters in GM soybean markets. Findings also suggest these two types of U.S. soybeans are incomplete substitutes. Moreover, any change in GM soybean price is likely to trigger greater effects on the price of non-GM soybeans.

As a counterpart of the U.S. powerhouse, Korea turns out to be a small importer. Therefore, Korea is a price taker in the world market. Finding such smallness of Korea is rather unique, in contrast to other Asian cases where Japan and China are posited to be able to mark-down their import prices. More specifically, different scopes of the U.S. market power to Korea (not statistically significant), Japan (4-6%), and China (13%) can be explained by each country's share in U.S. exports. China marks the largest share at 51%, followed by Japan at 4.5% and Korea at 1.3%. The other side of coin is that Korea has to rely on imported soybeans to a large extent. Thus, the country does not have much choice of exporters. In fact, a very limited number of exporting countries are known to meet the world demand for non-GM soybeans.

The identified oligopolistic pattern of U.S. exports to Korea suggests that diversified sources of import would generate potential economic gains to Korean buyers because fewer oligopolistic exporters in the market may charge a price that is above the marginal cost (Blavatskyy, 2018).

Overall, this paper contributed to the current understanding of market power in agricultural markets. Soybeans are relevant in terms of their scarcity as a research topic and data feasibility that makes it possible to test if non-GM and GM soybeans are under a similar market structure in Korea. On this basis, the present findings confirmed that the U.S. could exercise market power in soybean supply chains and reduce the quantity traded. By contrast, the weak degree of market power for Korea indicates that the quantity of import cannot be reduced to mark down the market price.

This study has some limitations, including the lack of production cost variables in RSE models and the model's disregard of multiple exporters or importers in the same country. Especially, the latter point has been dealt with the premise that a country can be represented as a share-weighted industry average for all firms. It is also worthy of note that a state trading enterprise (Korea Agro-Fisheries & Food Trade Corporation: aT) has been in charge of most non-GM soybean imports in Korea. Finally, potential roles of a mandatory GMO labeling measure, other policy instruments, and institutional schemes in determining market structure have previously never been addressed because of the lack of a theoretical framework.

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