An Empirical Analysis of Demand for U.S. Soybeans in the Philippines

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Abstract

To determine if the downward trend in U.S. market share of Philippine soybean imports is due either to inherent quality differences between soybeans from three competing exporting countries or to relative price changes, we analyze import quantity shares and relative prices of soybeans from Canada, China, and the U.S. to the Philippines. Results show that the Philippine soybeans import market exhibit low elasticity of import substitution, which implies greater rigidity in preferences. This reflects a market that is relatively more quality conscious. Market share trends, preference parameters, and price elasticities indicate strong preference by the Philippine market for U.S. soybeans relative to those from Canada and China. The downward trend in US market share can be explained by quality preferences rather than price factors.

Keywords: import demand, market share analysis, prices, quality, soybeans
JEL Classification: F10, F14, Q13, Q17

Introduction

The U.S. has been consistently the largest exporter of soybeans to the Philippines. From 1997 to 2012, the amount of US soybean exports to the Philippines average around 27 million kilograms per quarter, representing around 82 percent share of the total Philippine soybean imports (Figure 1 and Table 1). The U.S.'s key competitors are Canada and China, which capture on the average 14 percent and 5 percent Philippine market shares, respectively, during the same time period.

Soybean products such as soy sauce and tofu feature prominently in Philippine cuisine. Other soybean products such as feed and soy ink also sell in the Philippine market. With domestic soybean production at a marginal amount of less than 2,000 tons since 1999 according to the Food and Agricultural Organization, the Philippine market continues to be significant as an export destination. While this can be encouraging to U.S. soybean exporters, it is interesting to note that that the market share of US soybean exports to the Philippines is on a distinctly decreasing trend as shown in Figure 1. Identifying what explains this trend thus becomes crucial for the U.S. to remain competitive in the Philippine market.

Competitiveness in the international soybean trade market is not only driven by the price of soybeans, but quality as well. The relative importance of these factors depends on the tendency of the market to be price conscious on the one hand or quality conscious on the other (Wilson and Gallagher, 1990). To understand whether the Philippine soybean market is price or quality conscious, we analyze import quantity shares and relative prices of soybeans from Canada, China, and the U.S. This will determine whether the downward trend in the U.S. market share is due to inherent quality differences between soybeans from the three competing exporting countries or to relative price changes.

According to a report by the Foreign Agricultural Service of the U.S. Department of Agriculture, Philippine consumers are generally considered very price sensitive (U.S.

Department of Agriculture, 2009). As such, the decrease in demand for U.S. soybeans may have been due to relative price changes in favor of U.S. competitors. U.S. prices, however, are still competitive against Canada, while China prices, on the other hand, have shown an increasing trend in recent years (Figure 2). According to the same report, the Philippine market tends to have preference for U.S. food products because Philippine buyers perceive U.S.-produced products to be of consistently high quality. This argument is based on the concept that soybeans are heterogenous-like goods -- single commodity products that are considered heterogenous because of differences in product quality that arises mainly due to diversity in geographic and climatic factors, farmers' agronomic practices, government policies and regulations, and traders' marketing practices. These factors naturally vary across soybean exporting countries. For instance, comparing nutrient compositions of soybeans from Brazil, China, and the U.S, Grieshop and Fahey (2001), found that due to environmental conditions under which soybeans are grown, there are differences in crude protein, amino acid, and lipid concentrations of soybeans. These differences have the potential to yield competitive advantages in international trade. In other words, these quality differences are perceived to have an impact on the competitive behavior of exporters. As such, the decline in U.S. market share of soybean imports may have also been due to a probable shift in preferences towards quality inherent in soybeans from U.S. competitors.

The issue of determining the cause of U.S.'s declining market share in soybean imports is an empirical question, one that can be analyzed from elasticities and consumer preferences that can be estimated using a market share demand theoretical framework proposed by Case (1974). Using a set of assumptions, Case derived a system of market share demand equations where parameters can be calculated that would indicate individuals' preferences between heterogenous-like products. The system can likewise derive another parameter that estimates price responsiveness of market shares themselves. The Case methodology can therefore indirectly measure individuals' relative preferences between these heterogenous-like products.

The estimation results show a relatively low value of the elasticity of import substitution, which indicates less substitutability among imported soybean sources. The low price responsiveness implies greater rigidity in preferences and reflects a market that is relatively more quality conscious. Based on the calculated preference parameters, we also find that the Philippine market has strong preference for U.S. soybeans relative to those from Canada and China, which may imply that U.S. soybeans possess certain qualities favored by Philippine buyers. However, decreasing values of the preference parameters for US soybean imports over time implies that the Philippine market is increasingly showing interest in the quality of Canada and Chinese soybean as well. This result might also suggest a leveling of the playing field by other countries matching the quality of their soybeans to that of the U.S.

Model

The market share demand model used in this study is that introduced by Case (1974)

and further developed by Houck and Ryan (1978), Gallagher (1990), Kohli and Morey

(1990), and Wilson and Gallagher (1990). The premise for this market share demand

theory is that the probability of an individual supplier's good being chosen is based on

the relative price difference between that supplier's good and competing suppliers'

goods. The goods themselves are close substitutes, not perfect substitutes, such that

competitors are allowed to sell at different prices. In an N-competitor market, the

market share for good i, S_i, can be expressed as:

(1) $$S_i(p_1, p_2, \ldots, p_N) = \left[\left(\frac{m_i}{m_1} \times \frac{p_i}{p_1}\right)^\alpha + \left(\frac{m_i}{m_2} \times \frac{p_i}{p_2}\right)^\alpha + \cdots + \left(\frac{m_i}{m_N} \times \frac{p_i}{p_N}\right)^\alpha\right]^{-1}$$

where p_i is the price of good i, m_i is a measure of consumers' preference for good i, and

α measures the elasticity of substitution: the percentage change in relative market

shares for a 1 percent change in relative prices. Relatively large values indicate that

consumers adjust purchasing patterns quickly, and small values indicate slow

adjustments in purchasing patterns. An undifferentiated market where suppliers have

equal market share is indicated by $\alpha = 0$.

The model assumes that prices are exogenous and buyers in the market make

purchasing decisions based on relative prices.

Now, let $\beta_{ij} = m_i/m_j$, a measure of relative preferences. (1) becomes:

(2) $\quad S_i(p_1, p_2, \ldots, p_N) = \left[\left(\beta_{i1} \times \frac{p_i}{p_1}\right)^{\alpha} + \left(\beta_{i2} \times \frac{p_i}{p_2}\right)^{\alpha} + \cdots + \left(\beta_{iN} \times \frac{p_i}{p_N}\right)^{\alpha}\right]^{-1}$

and has the following properties:

    i.   The market shares depend only on the price ratios p_i/p_j.

    ii. $\sum_{i=1}^{N} S_i(p_1, p_2, \ldots, p_N) = 1$

    iii. $\lim_{p_i \to 0} S_i(p_1, p_2, \ldots, p_N) = 1$ for fixed p_j and $i \neq j$

The preference parameter, β_{ij}, captures the extent of consumers' preference for good i over good j. It also essentially measures the product differentiation between goods i and j. The market has a weak preference for good i compared to good j if:

$\beta_{ij} > 1 \quad for\ i \neq j$

On the other hand, the market has a strong preference for good i if:

$\beta_{ij} < 1 \quad for\ i \neq j$

The less differentiated the competing goods are, the closer the value of the preference parameter is to one. For the case of a homogenous product:

$\beta_{ij} = 1 \quad for\ i \neq j$

Relatively large values of β_{ij} indicate that the consumers adjust purchasing patterns quickly, and small values indicate slow adjustments in purchasing patterns.

By definition:

(3) $\quad \beta_{ij} = 1 \quad for\ i = j$

(4) $\quad \beta_{ij} = \dfrac{1}{\beta_{ji}}$

(5) $\qquad \beta_{ij} = \dfrac{\beta_{kj}}{\beta_{ki}} \quad$ for $k \neq i$ and $k \neq j$

This study considers that three suppliers are in competition to export a good to a

country. The market demand share equations for goods X_1, X_2, and X_3 are:

$$S_1 = \left[1 + \left(\beta_{12} \times \frac{p_1}{p_2}\right)^{\alpha} + \left(\beta_{13} \times \frac{p_1}{p_3}\right)^{\alpha}\right]^{-1}$$

(6) $\qquad$
$$S_2 = \left[\left(\beta_{21} \times \frac{p_2}{p_1}\right)^{\alpha} + 1 + \left(\beta_{23} \times \frac{p_2}{p_3}\right)^{\alpha}\right]^{-1}$$

$$S_3 = \left[\left(\beta_{31} \times \frac{p_3}{p_1}\right)^{\alpha} + \left(\beta_{32} \times \frac{p_3}{p_2}\right)^{\alpha} + 1\right]^{-1}$$

To incorporate structural shifts of preferences over time, β_{ij} is modified to

include a non-linear trend variable (T). The time trend also serves to capture the effects

of exogenous factors such as changes in per capita income, population, composition and

purchasing behaviors of export demand markets, and processing technology among

others:

$$\beta_{ij} = \beta_{ij}^{0} \times T^{\delta_{ij}}$$

where β_{ij}^{0} is the value of the preference parameter of good i over good j at the start of the

sample period, while δ_{ij} captures the annual shift in the preference parameter from

exogenous factors affecting the relative market share of good i relative to good j.

The system of market share demand equations then becomes:

$$S_1 = \left[1 + \left(\beta_{12}^0 \times T^{\delta_{12}} \times \frac{p_1}{p_2} \right)^\alpha + \left(\beta_{13}^0 \times T^{\delta_{13}} \times \frac{p_1}{p_3} \right)^\alpha \right]^{-1}$$

(7) $\qquad S_2 = \left[\left(\beta_{21}^0 \times T^{\delta_{21}} \times \frac{p_2}{p_1} \right)^\alpha + 1 + \left(\beta_{23}^0 \times T^{\delta_{23}} \times \frac{p_2}{p_3} \right)^\alpha \right]^{-1}$

$$S_3 = \left[\left(\beta_{31}^0 \times T^{\delta_{31}} \times \frac{p_3}{p_1} \right)^\alpha + \left(\beta_{32}^0 \times T^{\delta_{32}} \times \frac{p_3}{p_2} \right)^\alpha + 1 \right]^{-1}$$

(7) implies a log-linear form of the system of relative market share equations.

Focusing on the market share of exporter of good X_1, in particular, relative to the market

shares of exporters of goods X_2 and X_3, the equivalent system of log-linear equations are:

$$\ln \left(\frac{S_2}{S_1} \right) = \alpha \ln(\beta_{12}^0) + \alpha \delta_{12} \ln(T) + \alpha \ln \left(\frac{p_1}{p_2} \right)$$

(8)

$$\ln \left(\frac{S_3}{S_1} \right) = \alpha \ln(\beta_{13}^0) + \alpha \delta_{13} \ln(T) + \alpha \ln \left(\frac{p_1}{p_3} \right)$$

We apply the Case theoretical model to the case of soybean exports to the

Philippines, focusing on market share of soybeans from the U.S. relative to the markets

shares of soybeans from Canada and China. (8) provides the model specification to

determine soybean preferences of the Philippine market through analysis of the market

shares and simultaneously allow for the calculation of the import demand elasticities.

Using (3), (4), and (5) as cross-equation parameter restrictions in the estimation, we only

need to estimate (8), which is just two equations in a six-equation system. α, β_{ij}^0, and δ_{ij}

are the parameters to be estimated and from which all preferences and elasticities can

be derived.

To derive the import demand elasticities, let X_i be the quantity of exports from country i. By definition, in a three-exporter market:

$$X_i = S_i \times \sum_{i=1}^{3} X_i$$

We can evaluate the effects of a price change on imported quantities by differentiating and applying the Chain Rule:

(9) $$\frac{\Delta X_i}{\Delta p_j} = \sum_{i=1}^{3} X_i \times \left(\frac{\Delta S_i}{\Delta p_j}\right) + S_i \times \left(\frac{\Delta \sum_{i=1}^{3} X_i}{\Delta p_j}\right)$$

The model assumes that (i) multiple export demand markets with non-differentiated products, and (ii) no exporting country has a large enough share of the importing country's market to affect the total quantity of exports. This means that if relative prices change such that demand will move from one commodity to another, only relative market shares change; total demand remains the same. As such, changes in any one of the commodity prices will not affect the size of the market: the market size effect ($\Delta \sum X_i / \Delta p_j$) is zero. Therefore (9) is simply reduced to:

(10) $$\frac{\Delta X_i}{\Delta p_j} = \sum_{i=1}^{3} X_i \times \left(\frac{\Delta S_i}{\Delta p_j}\right)$$

Given this, the price elasticity from the market demand share functions ($E_{S_i p_j}$) estimated from (8) should be identical to the import demand price elasticity ($E_{X_i p_j}$). According to the corresponding import demand, own-price elasticity from the market share function is:

(11) $E_{X_i p_i} = E_{S_i p_i} = -\alpha(1 - S_i)$

while the corresponding import demand cross-price elasticity is:

(12) $E_{X_i p_j} = E_{S_i p_j} = \alpha S_i \quad \text{for i} \neq \text{j}$

The own- and cross-import demand price elasticities are bound by the elasticity of substitution (α). Furthermore, comparative statics yield that the own-price import demand price elasticity is an increasing function of market share and a decreasing function of the elasticity of substitution.

Data and Estimation Method

Data on soybean export quantities to the Philippines from Canada, China, and the U.S. and their corresponding prices are obtained from the Global Trade Atlas database of the Global Trade Information Services.[1] Quarterly time series data are used for the 16-year period from January 1997 to December 2012. Table 1 provides summary statistics of prices, quantity, and market share data used in the analysis. Average market shares show the Philippines soybean import market is dominated by imports from the U.S.

Since we are estimating a system of time series equations that are log-linear in the parameters and with cross-equation relationships among parameters and error terms, we estimate (8) using iterative seemingly unrelated regression method (SUR).

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[1] Global Trade Atlas website: http://www.gtis.com/GTA/ (Accessed: June 7, 2013).

Estimation using this method yields unbiased and more efficient parameter estimates in the presence of cross-equation serial correlation (Greene, 1993).

Results

Table 2 summarizes parameter estimates following specification of equation (8). Except for the U.S. trend coefficient relative to China, the regression coefficients are significantly different from zero. The elasticity of substitution, α, which reflects the sensitivity of market shares to changes in relative prices, shows a value of 0.63. This indicates that, on the average, a 1% increase in the relative price of U.S. soybeans caused the relative market demand share from either Canada or China to increase by 0.63%. This is a relatively low value, indicating less substitutability among imported soybean sources. The low price responsiveness implies greater rigidity in preferences and reflects a market that is relatively more quality conscious. Because the increase in relative demand share is less than the increase in price (0.63% < 1%), this implies that Philippine soybean purchasers are less likely to shift demand from U.S. to China or Canada when faced with an increase in U.S. price. This supports the fact that despite having a downward trend in market share, the U.S. has for the majority of the years remained the Philippines' largest exporter of soybeans.

The coefficients for the intercept and the trend variable are more meaningful if we derive the level of the preference parameter at the beginning of the estimation

period (first quarter 1997) and the annual changes thereafter. Table 3 provides the

computed initial preference values, and using the time trend value estimates, the

preference values at the end of the estimation period (fourth quarter 2012). Recall that

the value of the preference parameter, β_{ij}, and the extent of its deviation from 1 indicate

preference of soybeans from one source country relative to those from the other two

countries. The results show that the preference parameters for U.S. soybeans relative to

those from Canada and China are significantly below 1, indicating very strong

preference for U.S. soybeans. Wilson and Gallagher (1990), however, cautions

interpreting extreme values of β_{ij}, pointing to very little price responses and/or

exceedingly large or small shares as possible causes. Nevertheless, these extreme values

are very informative and indicate strong preferences for soybeans from the U.S.

Tremendous changes in relative prices will have to take place before any significant

changes in the relative market shares will occur. These results are consistent with the

estimated low elasticity of substitution value, α, which itself indicates low price

responsiveness of the Philippine market to changes in relative prices. Buyers respond

less to any change in relative prices because they have strong preference for one type of

soybeans, specifically those from the U.S. While there is a consistent preference for U.S.

soybeans in the 16 year time period, Table 3 shows that preference for U.S. soybeans by

the Philippine market has been decreasing relative to both Canada and China. Because

relative price does not seem to be a contending factor, this implies that the Philippine

market is increasingly considering non-price factors characterizing Canadian and Chinese soybeans.

Table 4 provides the computed own-price import demand elasticities and cross-price import demand elasticities, which are also derived from reported coefficients in Table 2. Own- and cross-price import demand elasticities were computed at the mean. The import demand elasticities, computed at the share mean, still indicate the Philippine market's preference for U.S. soybeans. The import demand price elasticity for Canada and China, despite being low at − 0.57 and − 0.61 respectively, are still relatively more elastic than that for the U.S. (− 0.23). This means that even if U.S. soybean prices increase, current buyers of U.S. soybeans are less likely to shift to soybeans from other exporting countries. Consistent with the results in Table 3, however, the import demand price elasticity for U.S. soybeans has been increasing in absolute value (see Figure 3). With Canada and China's price elasticities relatively stable, this indicates that through the years, the Philippine market might approach sensitivity to U.S. prices equivalent to its sensitivity to Canada and China prices. Note that because these elasticities ranges are still at low levels of around -0.5 to -0.6, this indicates that eventually these three countries would still compete on a quality-conscious Philippine market.

Concluding Remarks

The low price response parameter and consistently high preference parameter for U.S. soybeans imply that the Philippines market is quality-conscious. This does not imply that the U.S. has better quality soybeans than those from Canada and China, but that Philippine buyers have rigid preferences for particular quality that seems to be present in U.S. soybeans. This, however, points out to one limitation of this study. We assume that source of origin is important in determining export competitiveness, but we cannot specify exactly why differences exist. In particular, what qualities in soybeans seem to be giving U.S. competitive advantage over Canada and China? Given that from the estimation results, there is a shift in preferences over time, supported by a decreasing trend in the U.S. market share, what qualities in Canada or China soybeans are causing Philippine buyers to slowly shift away from U.S. soybeans? Finally, another shortcoming of this study is that the Case model used to estimate Philippine import demand elasticities by country of origin assumes constant elasticity of substitution.
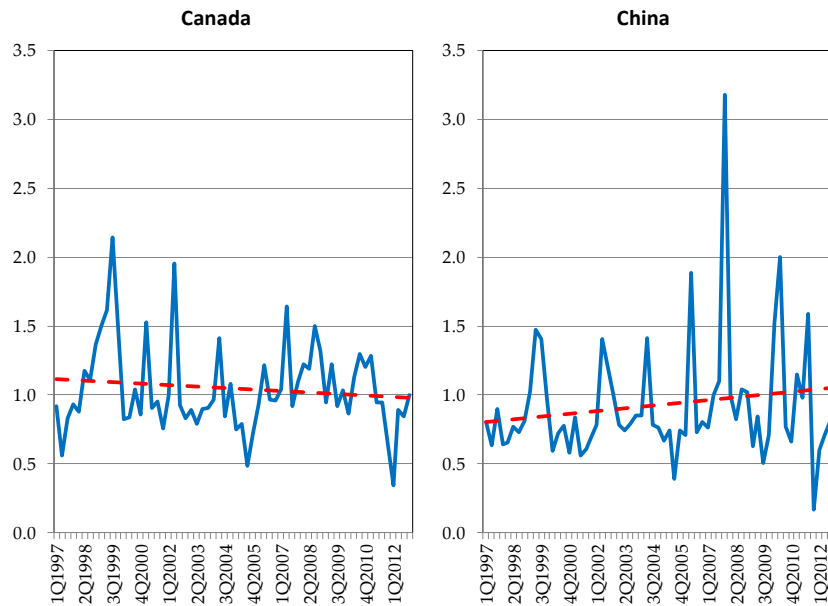
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Figure 1
U.S. Soybean Quantity Shares, Philippines Imports
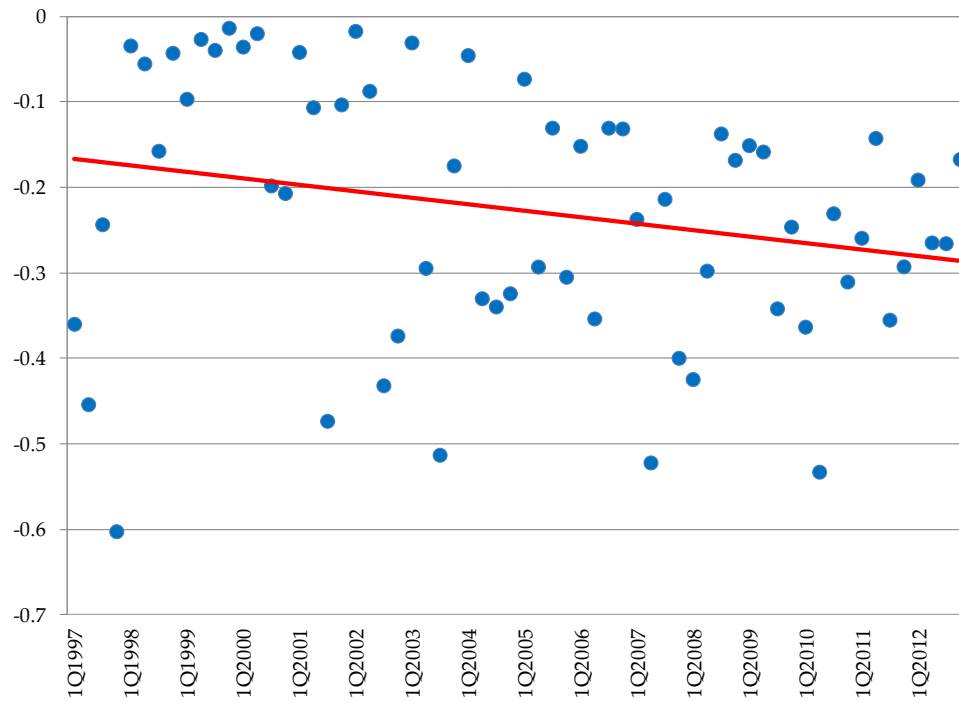**(First Quarter 1997 to Fourth Quarter 2012)**
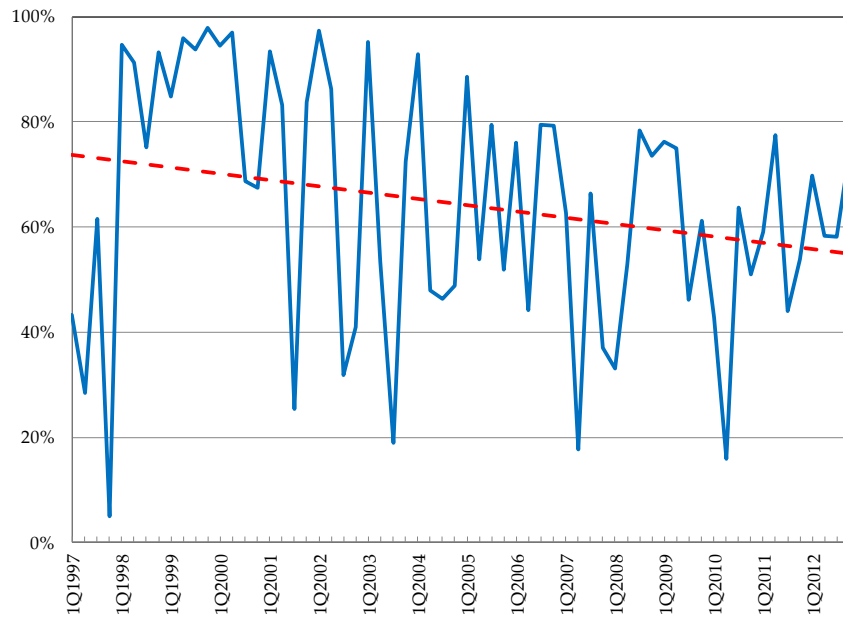
Source: Global Trade Atlas, *Global Trade Information Services*.

Figure 2
Ratio of U.S. Price to Canada and China Prices of Soybean Imports, Philippines
(First Quarter 1997 to Fourth Quarter 2012)

Source: Global Trade Atlas, *Global Trade Information Services*.

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Figure 3
Import Demand Point Elasticity Over Time for U.S. Soybean Imports to the Philippines
(First Quarter 1997 to Fourth Quarter 2012)

Source: *Authors estimates.*

Table 1
Summary Statistics of Philippine Import Quantities and Prices by Origin
(First Quarter 1997 to Fourth Quarter 2012)

Origin	Average	Standard Deviation	Minimum	Maximum
Price (U.S. dollars per kilogram)				
United States	0.33	0.11	0.16	0.61
Canada	0.33	0.11	0.17	0.70
China	0.41	0.31	0.11	2.67
Quantity (in thousands kilograms)				
United States	27,109.50	25,142.41	645.65	89,113.50
Canada	2,416.54	3,406.40	494.56	26,956.68
China	811.84	1,416.23	24.05	6,988.14
Market Shares (percentage)				
United States	81.99	15.38	39.75	98.18
Canada	13.50	11.97	1.04	50.84
China	4.51	7.59	0.40	44.15

Notes:
1. Number of Observations: 64
2. For the market shares, we assume the market consists of imports from only the United States, Canada, and China.

Table 2
Parameter Estimates for Soybean Exports to the Philippines
(First Quarter 1997 to Fourth Quarter 2012)

Variable	Parameter	Equation $\ln\left(\frac{S_2}{S_1}\right)$	Equation $\ln\left(\frac{S_3}{S_1}\right)$
$\ln\left(\dfrac{p_1}{p_j}\right)$	α	0.6330 * (0.2757)	0.6330 * (0.2757)
$\ln(T)$	$\alpha\delta_{1j}$	0.3903 * (0.1627)	0.1113 (0.1661)
Intercept	$\alpha\ln\left(\beta_{1j}^0\right)$	− 3.4667 ** (0.5416)	− 3.8659 ** (0.5416)
Model χ^2		10.85 **	5.99 *

Notes:
1. Number of observations: 64.
2. **,* denote statistical significance at 1% and 5% levels, respectively.
3. Standard errors are in parentheses.
4. Subscript assignments: United States (1), Canada (2), and China (3).
5. The Breusch-Pagan test of independence χ^2-statistic with 1 degrees of freedom is 24.529 (significant at 1%).

Table 3
Complete Preference Parameter Estimates
(United States, Canada, and China Soybean Exports to the Philippines)

	First Quarter 1997			Fourth Quarter 2012		
	U.S.	Canada	China	U.S.	Canada	China
United States	–	0.0042	0.0022	–	0.0543	0.0046
Canada	239.1020	–	0.5323	18.4046	–	0.0852
China	449.1902	1.8787	–	216.1392	11.7438	–

Notes:
1. The preference parameters represent the level of product differentiation between two goods. They are price premiums or discounts, relative to imports from United States, that would provide each good equal market share.

Table 4
Demand Elasticities for United States, Canada, and China Soybean Exports
to the Philippines

Country/Timeframe	Elasticity of Demand at Share Mean	
	Own-Price	Cross-Price *
United States	– 0.2264	0.4066
Canada	– 0.5690	0.0640
China	– 0.6137	0.0193

Note:
1. * - Cross-price elasticities refer to the percentage change in the quantities imported of soybeans from other countries for a one percent change in the price of indicated country source.