MARKET POWER OF THE JAPANESE NON-GM SOYBEAN IMPORT MARKET

by

KOICHI YAMAURA

B.A., Toyo University, 2004

A THESIS

submitted in partial fulfillment of the requirements for the degree

MASTER OF SCIENCE

Department of Agricultural Economics
College of Agriculture

KANSAS STATE UNIVERSITY
Manhattan, Kansas

2008

Approved by:

Major Professor
Michael Woolverton

Abstract

Globally, the majority of countries now use genetically modified (GM) soybeans to produce oil and meal for livestock and human consumption. Japan, however, uses only Non-GM soybeans for direct human consumption of which more than 80% are imported from the U.S., Canada, and China. This research used the inverse residual demand model to estimate a two-country partial equilibrium trade model to test the existence of market power in the Japanese Non-GM soybean import market. The two-country partial equilibrium trade model incorporated the U.S. residual Non-GM soybean supply for Japan, the Japanese residual demand for U.S. Non-GM soybeans, and the equilibrium condition, where the U.S. residual Non-GM soybean supply equals the Japanese residual Non-GM soybean demand. Monthly data from January 2003 to December 2007 were used for the analysis. Empirical results indicated that U.S. Non-GM soybean exporters have stronger market power than Japanese Non-GM soybean importers. The results also indicate that Japanese consumers are willing to pay higher prices for soybeans, tofu, natto, miso, and other all soy food products.

Table of Contents

List of Figures

List of Tables

Acknowledgements

I would first like to thank Dr. Michael Woolverton for his assistance throughout the process of formulating this thesis. His contribution of both time and effort along the way is greatly appreciated. Without his input, this thesis would not have been possible. I would also like to thank my committee, Dr. Vincent Amanor-Boadu and Dr. Michael Boland for their great help. I also thank to the Kansas Soybean Commission for partially funding research for this thesis. Also, I would like to give a special thanks to all the graduate students that helped with problems along the way. If there was a problem, there was always someone supplying aid. Last, but not least, I would like to give a sincere thank you to my parents; Hideo and Harue Yamaura, sister, grandmother, and Veru. Without their support, none of this would have been possible. Without a doubt, they have been, and will continue to be, the most influential people in my life.

CHAPTER 1 - Introduction

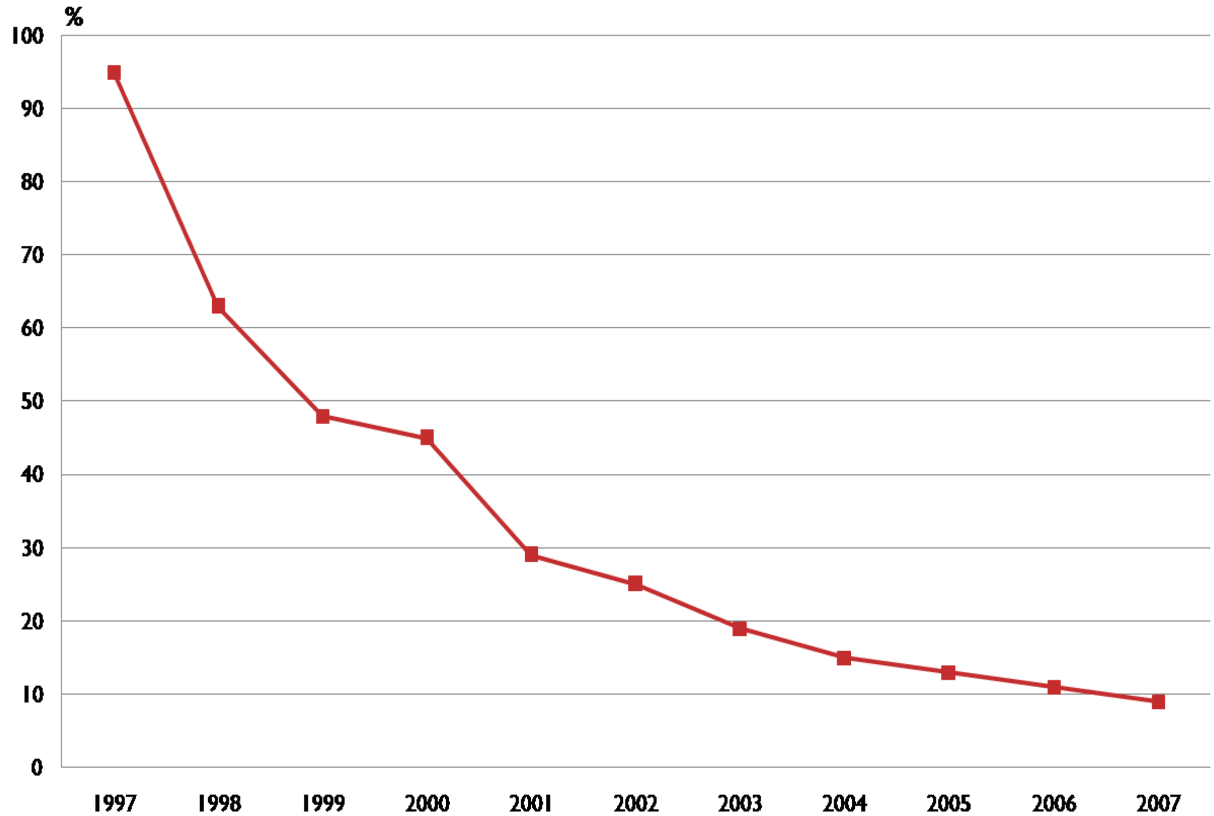
1.1 Background

In the past 100 years, Japan has changed from being a self-sufficient country to an industrially-advanced country that relies heavily on trade. As a result, Japanese citizens enjoy a high standard of living. But except for rice, Japan must import food commodities from all over the world. At present, the country's food self-sufficiency ratio is 39% (calorie base), which means that Japan depends on imports for 61% of its food supply. The self-sufficiency ratio in grains is 27% (MAFF 2003). For food grade soybeans, the self-sufficiency ratio, which has declined year by year, was only 15 percent in 2004. Some studies suggest that the decreasing Japanese self-sufficiency ratio may result in future problems (MAFF 2006).

The United States is the leading soybean producer in the world. In the past decade, genetically modified (GM) soybean acreage has rapidly increased. Most of the major soybean importing countries, including China, Mexico, and South Korea, reading accept imports of GM soybeans for all uses. On the other hand, Japan, the world's third largest soybean importer, has insisted on importing only Non-GM soybeans for direct human consumption. Japan's major suppliers are the U.S., Canada, and China. Japan will likely continue to be the world's largest importer of Non-GM soybeans.

Figure 1.1 shows the U.S. Non-GM soybeans share of the total U.S. soybean acreage. In 1997, U.S. Non-GM soybeans were planted on over 95% of the total U.S. soybean acres. But GM soybean technology has been adopted rapidly by U.S. soybean farmers. As a result, Non-GM soybeans share decreased to less than 50% of the total soybean acreage by 1999. Non-GM soybean share has continued to fill in the new century to only 9% of total U.S. soybean acreage.

Figure 1.1 Non-GM Soybean Share in the Total Soybean Acreage of the U.S. (1997-2007)



Source: USDA-ERS, 2008

1.2 Short History of Food Soybeans in Japan

In the 1930's, Japan was self-sufficient in food-grade soybean production. Japan started to import soybeans, primarily for oil in the 1940's. By the 1950's, the amount of soybeans produced in Japan was approximately equal to soybean imports. During the 1960's, the amount of imported soybeans surpassed the amount of domestically produced soybeans. In 1972, the tariff on soybean imports was eliminated. In a short time, approximately eighty percent of all soybeans consumed in Japan were imported. United States produced soybeans made up 90% of soybeans imported into Japan. In the 1990's, consumption of GM soybeans became an increasingly important issue in Japan. Japanese consumers drove the debate by increasingly choosing to purchase Non-GMO products. In 2000, all soy products manufacturers fully shifted to Non-GM soybeans for tofu and natto production in Japan.

1.3 Objectives of Research

Given the above facts, the Japanese Non-GM soybean import market can be characterized as a monopsony if all Japanese Non-GM soybean importers are viewed as one buyer. If all exporters in each country are aggregated, U.S., Canada, and China can be viewed as an oligopoly. The question then becomes who has more market power: the monopsony or the oligopoly? The party to a trade negotiation with the strongest market power can negotiate a more favorable price or other terms of trade than a trading partner with relatively weak market power. Estimating who has stronger market power should be of interest to both Non-GM soybean exporting countries and a Non-GM soybean importing country.

There are U.S., Canadian, and Chinese Non-GM soybean exporters in the Japanese Non-GM soybean market but U.S. Non-GM soybeans share over 70% in the Japanese Non-GM soybean market. Thus it is important to know the market power relationship of the United States compared to Japan. U.S. policymakers would be in better position trade policies that could expand the U.S. market share in the Japanese Non-GM soybean import market. Japanese policy makers may be able to change trade policies to forestall future problems of relying on a powerful trade partner, such as the United States.

To determine relative Non-GM soybean market power relationships, this research will employ a two-country partial equilibrium trade model to test market power relationships for the Japanese Non-GM soybean import market.

1.4 Thesis Organization

This thesis is organized as follows: The literature review and an overview of food soybean products are presented in Chapter Two. Chapter Three contains the theoretical models, variable identification, and the statistical and econometric analyses. Conclusions and recommendations are presented in Chapter Four.

CHAPTER 2 - Literature Review and Overview of the Food Soybean Trade between the U.S. and Japan

2.1 Literature Review

The Lerner Index (Lerner 1934) for measuring the market power of a single firm was created in 1934. Also, the Lerner Index can be used to measure the degree of market power of a firm in an imperfect market. The Lerner Index is defined as:

$$LI = \frac{P - MC}{P} \quad (1)$$

where the variable P is the market price and MC is the marginal cost. However, measuring the degree of the market power is difficult using an empirical model because of the difficulty in obtaining marginal cost data.

Carter et al. (1999) estimated the world wheat market by using the Residual Demand Elasticity (RDE) model. It was a new approach to measuring the market power of individual countries for wheat. Carter et al. assumed that each country was a firm, and those parameters could be interpreted as the share-weighted industry averages for all firms within one country. Based on Goldberg and Knetter's (1999) RDE model, Carter et al. directly defined the reduced form of the inverse residual demand function for the U.S. wheat as:

$$LnP_t^u = \alpha + \eta^u LnQ_t^u + \beta^c LnW_t^c + \beta^a LnW_t^a + \gamma LnZ_t + \varepsilon_t \quad (2)$$

where the variable P_t^u is the price of the U.S. wheat exported to Japan, and the variable Q_t^u represents the quantity of the U.S. wheat export to Japan. The vector W_t^c is a set of cost shifters for the U.S. export competitor, Canada, and the vector W_t^a is a set of cost shifters for another

U.S. export competitor, Australia. The vector Z_t includes demand shifters in Japan. α, η, β and γ are estimated parameters. The error term, ε, is assumed to be distributed independently and identically. The subscript, *t*, is time period. Carter et al. estimated the price flexibility for the U.S. wheat exports to Japan directly by using the double-log form.

Carter et al. estimated their model (2) by using quarterly data from 1970 to 1991. These results indicated that "the United States is possibly a price leader in the Japanese market for imported wheat whereas Australia and Canada form a competitive fringe."

2.2 Overview of the Food Soybean Trade between the U.S. and Japan

In this section, first, will be explained the characteristics of the major soybean foods in Japan. Second, an overview will be presented of the food soybean trade between the U.S. and Japan.

Japanese Soy-Foods

There are many food soybean products consumed around the world. For instance, tofu, soy milk, and soy sauce are popular in many countries. Consumption of other soybean foods, however, tend to be limited primarily to specific regions. For example, soy cheese, soy yogurt, and soy ice cream are popular products in the U.S., but only specialty soybean stores sell these soybean foods in Eastern Asia. Doenjang is a traditional Korean fermented soybean paste and it is popular only in North and South Korea. Doubanjiang is a spicy, salty paste and it is one of the most popular soybean products in China. It made from fermented soybeans, broad beans, red chili peppers, salt, and spices. This paste is usually eaten with rice or noodles as a quick meal in China. Tempeh is made by a natural culturing and controlled fermentation process that binds soybeans into a cake form. It originated on the Indonesian island of Java but is popular only in Indonesia.

Tofu has a long history in the Eastern Asian countries including in China, Japan, North and South Korea, and Taiwan. Tofu has been accepted as a health food in the U.S. and European Union (EU). Since this research is focused on Japan, thus, the Japanese tofu manufacturing process will be examined in detail. Tofu is solidified soymilk. In the Japanese production process for tofu, tofu manufacturers soak soybeans in water for about eight hours so all the soybeans to absorb water. Then the soybeans are crushed and boiled in hot water to obtain soymilk. "Nigari (magnesium chloride)," a coagulant, is added to soymilk to solidify the liquid into tofu. There are many ways of cooking tofu in Japan. One of the most popular tofu dishes is Hiyayakko. Hiyayakko is raw tofu with minced green onions, topped with sliced dried bonito and soy sauce. Another popular tofu dish is Yu-dofu. Yu-dofu is boiled tofu in soup stock. Many Japanese eat it with minced green onions and soy sauce during the winter. Also, it is popular to cut it into small cubes and put it into miso soup.

Natto is an ethnic Japanese food of fermented whole soybeans. Natto soybeans are characterized by small seed size, which can be a maximum of only 5.5 mm diameter. Natto soybeans must also have a clear hilum, thin seedcoat, and high carbohydrate content. To make natto, the special natto soybeans are soaked in water to permit the seeds to absorb water. Then the soybeans are boiled in hot water and natto bacteria are sprayed on the cooked soybeans. The natto inoculated soybeans are put into a warm storage house for more than eight hours to permit fermentation. Natto has a cheesy consistency and a pungent smell that can be overpowering to first-time consumers. The fermentation process makes the soy protein more readily digestible. For centuries, natto has been popular in parts of Japan as a flavoring, especially as topping on rice for breakfast (Norris 2006). Natto is packaged in small white plastic packages with soy sauce and mustard.

Miso is fermented and salted soybean paste. Raw soybeans are steamed, mashed and mixed with a small amount of steamed rice and/or wheat. The mixture is fermented in a warm storage house after miso bacteria have been sprayed onto the mash. The matured, fermented soybean paste, then, becomes miso in paste form. Miso is usually sold in 300-500 gram (10.6-17.6 oz) plastic containers in supermarkets. Although it is used primarily as a seasoning, miso soup is one of the most popular foods made from miso. It is usually served with rice at breakfast and supper meals. There, however, are many other ways to use miso paste. For example, miso is put on sliced, raw mackerel before grilling. This is one of the most popular fish dishes in Japan and people usually eat it with rice. Also, people like to eat vegetable sticks dipped in miso. Miso flavored pickles are very popular in Japan, too.

The Non-GM Soybean Trade

In this section, will be described the Non-GM soybean importers and exporters. Secondly, the distribution system for Non-GM soybeans from the U.S. producers to the Japanese soybean food makers will be discussed.

Japanese trading companies import Non-GM soybeans into Japan. Japanese trading companies do not deal exclusively in one specific product or product group, but rather deal in many products. A typical leading trading company will buy or sell almost anything, including industrial goods, textile goods, raw materials including agricultural products and mineral resources among other products. There are eight Japanese trading companies in that import food soybeans. On the other side of the trades are U.S. grain exporters that sell the soybeans to Japanese trading companies.

There are two principle ways to ship U.S. soybeans to Japan. One is bulk shipment, and the other is container shipment. Bulk shipment is typically used for large-volume sales of commodity soybeans. The most common bulk shipment size is 40000 metric tons. Not all soybean trading companies can finance the large quantity required to fill a vessel of that size. Only the four largest Japanese trading companies have the capability to charter vessels (Fukunaga, 2003).

Container shipments have become more popular in recent years for soybean trading in shipping specialty soybeans from the U.S. to Japan. They are especially useful for shipping identity preserved (IP) soybeans. Many Japanese soybean food manufactures have shifted from Indiana, Ohio, and Michigan (IOM) commodity soybeans to variety soybeans, thus container shipments are used more. Soybean shipments commonly are placed in 20 foot long containers, which hold approximately 20 metric tons of soybeans. Variety soybeans are screened and bagged before going into containers. Container shipments are well suited for IP shipment of specialty soybeans. It nearly eliminates the risk of contamination by other varieties of soybeans.

Bulk shipments of U.S. soybeans bound for Japan are usually shipped in self-trimming bulk carriers (STBC). Soybeans are moved mostly by rail from Midwestern farms to New Orleans export terminals. A single farm may grow six to ten different varieties of soybeans which are usually mixed together as the soybeans are moved into the market channel. To produce and sell IP specialty soybeans, a farmer must thoroughly clean the several kilograms of soybeans that are retained in the nooks and crannied of a combine after the bin has emptied. It can take a farmer as long as three hours to clean a combine completely. Farm trucks unload commodity soybeans at a rate of one every three to four minutes during harvest time at most country grain elevators. However, for specialty soybeans, the pace of unloading must be slowed considerably for grain handling systems at the elevators to be cleaned between truckloads. To transport specialty soybeans, farmers may have to transport partial truckloads from farms. But, grain merchandising companies prefer to fill rail cars and trucks to full capacity for transporting from country elevators to river terminals. Specialty soybeans from several elevators may have to be loaded together to make a barge load at river terminals. Specialty soybeans may occupy only one of many holds in an oceangoing vessel at the Port of New Orleans. Accidental intermixing of different varieties of soybeans can occur when soybeans are blown into an adjacent hold by wind. This can severely reduce the value of a specialty soybean shipment.

Many of problems associated with the bulk shipment of specialty soybeans can be eliminated by shipping in containers. Specialty soybeans from country origination points are loaded into containers which are loaded onto rail flatcars. Then, stacked railcars are moved to the export terminal. Identity of the specialty soybeans can be maintained country elevator to the Japanese food manufacture. There are three sizes 20-, 40-, or 45-foot of ocean-shipping containers available. The most common size used for specialty soybeans is the 20-foot container. There are many advantages of using containers, such as to reduce shipping risks, theft, handling damage, adverse temperatures, or risk of accidental mixing. Specialty soybeans may even be purchased directly from a farmer. U.S. soybeans shipped in containers usually maintain in high quality because there is less damage to the soybeans in transit and foreign material levels are lower. Also demurrage on containers is much lower than for vessels, thus there is less financial risk (USSEC).

CHAPTER 3 - Theoretical Model, Variable Identification, and Empirical Estimation and Interpretation

3.1 Introduction

As shown by most previous research in international agricultural trade, people believe that importers have more market power than exporters, both in competitive and non-perfect competitive markets.

This research is focused on the food soybean market in Japan. As discussed in Chapter 2, Japan has a unique food soybean market. Japanese people consume only Non-GM soybeans, therefore Japan imports only Non-GM soybeans from the U.S., Canada, and China. In order to use the two-country partial equilibrium trade model, Japan is considered a monopsony by aggregating all Japanese Non-GM soybean importers. On the other side are the U.S., Canada, and China which makes up a three-country oligopoly of soybean sellers. If Japan as a country is a monopsonistic Non-GM soybean importer, it may have more market power than any one of the Non-GM soybean exporting countries. This research seeks to test who has the stronger market power in the Japanese Non-GM soybean import, buyer or seller.

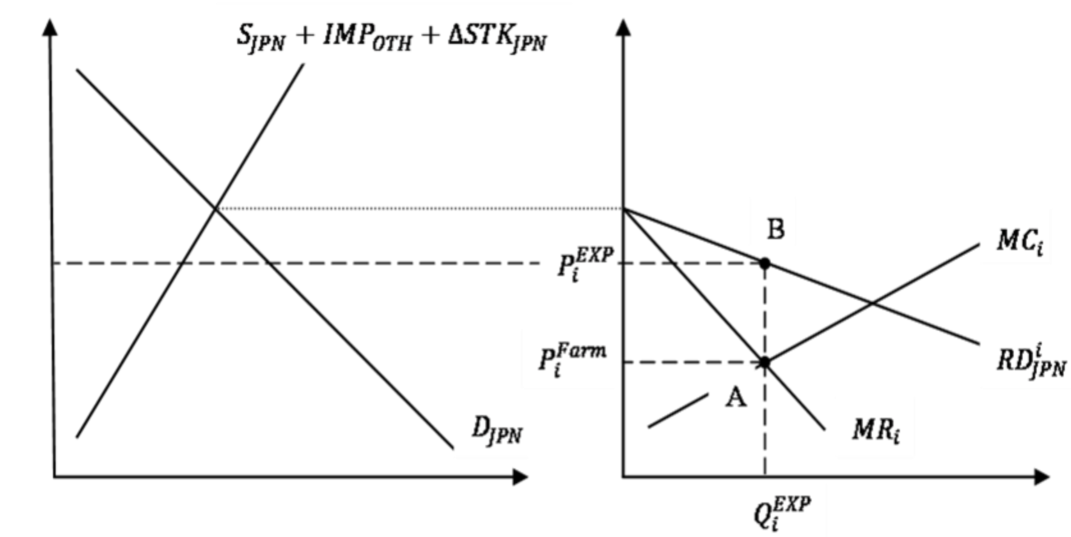
To measure the market power of Japan as a Non-GM soybean buyer, the inverse residual Non-GM soybean demand and the inverse residual Non-GM soybean supply were estimated. In the two-country partial equilibrium Non-GM soybean trade model, the inverse residual Non-GM soybean demand and the inverse residual Non-GM supply were combined to estimate relative market power.

3.2 Theoretical Models

Japanese Inverse Residual Non-GM Soybean Demand Model

According to Song "…all the soybean exporters in the soybean exporting country can be considered as an aggregated firm, estimated coefficients can be interpreted as the share-weighted industry averages for all soybean exporters in a soybean exporting country…" Song (2006). If Non-GM soybeans are assumed to be homogeneous, estimated coefficients can be expounded as the share-weighted industry averages for all Non-GM soybean exporters in the Non-GM soybean exporting countries. In that case all individual Non-GM soybean exporters in one country can be treated as an aggregated firm.

Figure 3.1 Japanese Residual Non-GM Soybean Demand for Country *i* based on model's shown Song(2006)



Japanese Domestic Non-GM Soybean Market

Non-GM Soybean Exports of Country *i*

--Japanese Residual Non-GM soybean Demand for Country *i*

i= the U.S., Canada, and China

In the right panel of Figure 3.1, it is assumed that Non-GM soybean exporters in country *i* face a downward sloping residual Non-GM soybean demand curve, RD^{i}_{JPN} , from Non-GM soybean exporting country *i*'s perspective.

The curves MC_i and MR_i represent the marginal cost for Non-GM soybean exporters in country *i* and the marginal revenue for Non-GM soybean exporters in country *i*. For maximizing Non-GM soybean export profits, Non-GM soybean exporters in country *i* choose point A in Figure 3.1, right panel, where the marginal cost equals the marginal revenue, as the optimal quantity supplied. Accordingly, the equilibrium export quantity is Q_i^{EXP} at the equilibrium export price, P_i^{EXP} . The distance between A and B can be viewed as the mark-up for Non-GM soybean exporters in country *i*.

Non-GM soybean exporters in country *i* choose export quantity to Japan, Q_i^{EXP} , to maximize their profits, $\prod_i$.

$$\max_{Q_i^{EXP}} \prod_i = P_i^{EXP}(Q_i^{EXP}) * Q_i^{EXP} - (P_i^{Farm} + C_i) * Q_i^{EXP} \qquad (3)$$

where $\prod_i$ represents profits obtained by Non-GM soybean exporters in country *i*, where *i* could be the U.S., Canada, or China. The variable P_i^{EXP} is Non-GM soybean export price received by country *i*, which is a function of the export quantity, Q_i^{EXP} . The variable P_i^{Farm} is Non-GM soybean farm level price in country *i* or the exporter's purchase cost from Non-GM soybean farmers in country *i*. The variable C_i is Non-GM soybean exporter's transaction costs in country *i*.

The first order condition (FOC) of equation (3) is,

$$\frac{\partial \prod_i}{\partial Q_i^{EXP}} = \left(\frac{\partial P_i^{EXP}}{\partial Q_i^{EXP}} * Q_i^{EXP} + P_i^{EXP} \right) - \left(P_i^{Farm} + C_i \right) = 0 \tag{4}$$

$$P_i^{EXP} - \left(P_i^{Farm} + C_i \right) = -\frac{\partial P_i^{EXP}}{\partial Q_i^{EXP}} * Q_i^{EXP}$$

$$\frac{P_i^{EXP} - \left(P_i^{Farm} + C_i \right)}{P_i^{EXP}} = -\frac{\partial P_i^{EXP}}{\partial Q_i^{EXP}} * \frac{Q_i^{EXP}}{P_i^{EXP}} \tag{5}$$

The left side of equation (5) represents the market power for Non-GM soybean exporters in country *i* over the Japanese Non-GM soybean importers. Also, the left side of equation (5) is similar to the Lerner Index, which is equation (1). In this paper, the market power for Non-GM soybean exporters in country *i* over the Japanese Non-GM soybean importers as the Adjusted Lerner Index for country *i*, ALI_i. It can be written as:

$$\frac{P_i^{EXP} - \left(P_i^{Farm} + C_i \right)}{P_i^{EXP}} = ALI_i \tag{6}$$

The right side of equation (5) is the price flexibility of the Japanese inverse residual Non-GM soybean demand from exporting country *i*. Therefore, the price flexibility of the Japanese inverse residual demand for Non-GM soybeans from exporting country *i* can be used as an indirect measure to evaluate the market power of Non-GM soybean exporters in country *i*.

By using equation (5), the relationship between the Non-GM soybean export price in country *i* and the Non-GM soybean farm level price in country *i* can be derived. Assuming that a Non-GM soybean exporter’s transaction costs in country *i* are a constant ratio, γ_i , of the Non-GM soybean farm level price in country *i*, it can be written as:

$$C_i = \gamma_i * P_i^{Farm} \tag{7}$$

The price flexibility of the Japanese inverse residual demand for Non-GM soybeans from country *i* is θ_i^{JPN} , where:

$$\theta_i^{JPN} = \frac{\partial P_i^{EXP}}{\partial Q_i^{EXP}} * \frac{Q_i^{EXP}}{P_i^{EXP}} \tag{8}$$

Substituting equation (7) and (8) into (5), equation (5) can be written as:

$$\frac{P_i^{EXP} - \left(P_i^{Farm} + \gamma_i P_i^{Farm}\right)}{P_i^{EXP}} = -\theta_i^{JPN}$$

$$P_i^{EXP} - \left(P_i^{Farm} + \gamma_i P_i^{Farm}\right) = -\theta_i^{JPN} * P_i^{EXP}$$

$$P_i^{EXP} - \left(1 + \gamma_i\right) * P_i^{Farm} = -\theta_i^{JPN} * P_i^{EXP}$$

$$\left(1 + \gamma_i\right) * P_i^{Farm} = \left(1 + \theta_i^{JPN}\right) * P_i^{EXP}$$

$$P_i^{Farm} = \frac{\left(1 + \theta_i^{JPN}\right)}{\left(1 + \gamma_i\right)} * P_i^{EXP} \tag{9}$$

and set:

$$\varphi_i = \frac{\left(1 + \theta_i^{JPN}\right)}{\left(1 + \gamma_i\right)} \tag{10}$$

Then, equation (9) can be written as:

$$P_i^{Farm} = \varphi_i * P_i^{EXP} \tag{11}$$

Equation (11) shows a linear relationship between Non-GM soybean farm level price and Non-GM soybean export price in country *i.* It is assumed that in the short-run, the price flexibility of the Japanese inverse residual Non-GM soybean demand is constant.

As shown in Figure 3.1, the Japanese residual demand for exporting country *i*'s Non-GM soybeans, RD_{JPN}^{i}, equals the Japanese domestic Non-GM soybean demand, D_{JPN}, minus the Japanese domestic Non-GM soybean supply, S_{JPN}, minus the Japanese Non-GM soybean imports from countries other than country *i*, IMP_{JPN}^{OTH}, plus the net change of the Japanese Non-GM soybean stocks, STK_{JPN}. The Japanese residual demand function for country *i*'s Non-GM soybeans can be written as:

$$RD^{i}_{JPN} = D_{JPN} - \left(S_{JPN} + IMP^{OTH}_{JPN}\right) + \Delta STK_{JPN} \tag{12}$$

where the Japanese domestic demand and supply functions are:

$$D_{JPN} = D_{JPN}\left(P^{R}_{JPN}; Z^{D}_{JPN}\right) \tag{13}$$

$$S_{JPN} = S_{JPN}\left(P^{R}_{JPN}; Z^{S}_{JPN}\right) \tag{14}$$

and where the variable Z^{D}_{JPN} is a vector of the Japanese demand shifters including income and population. P^{R}_{JPN} is the Japanese domestic Non-GM soybean retail price. Z^{S}_{JPN} is a vector of the Japanese supply shifters including production cost, etc. The Japanese Non-GM soybean imports from countries other than country *i* and the net change of the Japanese Non-GM soybean stocks are considered as exogenous variables in this research.

The Japanese domestic demand and supply functions substitute into the Japanese residual demand function for country *i*'s Non-GM soybeans thusly:

$$RD^{i}_{JPN} = RD\left(P^{R}_{JPN}; Z^{D}_{JPN}, Z^{S}_{JPN}, IMP^{OTH}_{JPN}, \Delta STK_{JPN}\right) \tag{15}$$

To consider the relationship between the Japanese Non-GM soybean import price for soybeans from exporting country *i*, the Japanese domestic Non-GM soybean retail price is substituted into the Japanese residual demand function for country *i*'s Non-GM soybeans to obtain:

$$RD^{i}_{JPN} = RD\left(P^{i,IMP}_{JPN}; Z^{D}_{JPN}, Z^{S}_{JPN}, IMP^{OTH}_{JPN}, \Delta STK_{JPN}\right) \tag{16}$$

Writing the equation in its inverse form, it becomes:

$$P^{i,IMP}_{JPN} = P^{i,IMP}_{JPN}\left(RD^{i}_{JPN}; Z^{D}_{JPN}, Z^{S}_{JPN}, IMP^{OTH}_{JPN}, \Delta STK_{JPN}\right) \tag{17}$$

Equation (17) is the Japanese inverse residual demand function for exporting country *i*'s Non-GM soybeans.

Exporting Country i's Inverse Residual Non-GM Soybean Supply Model

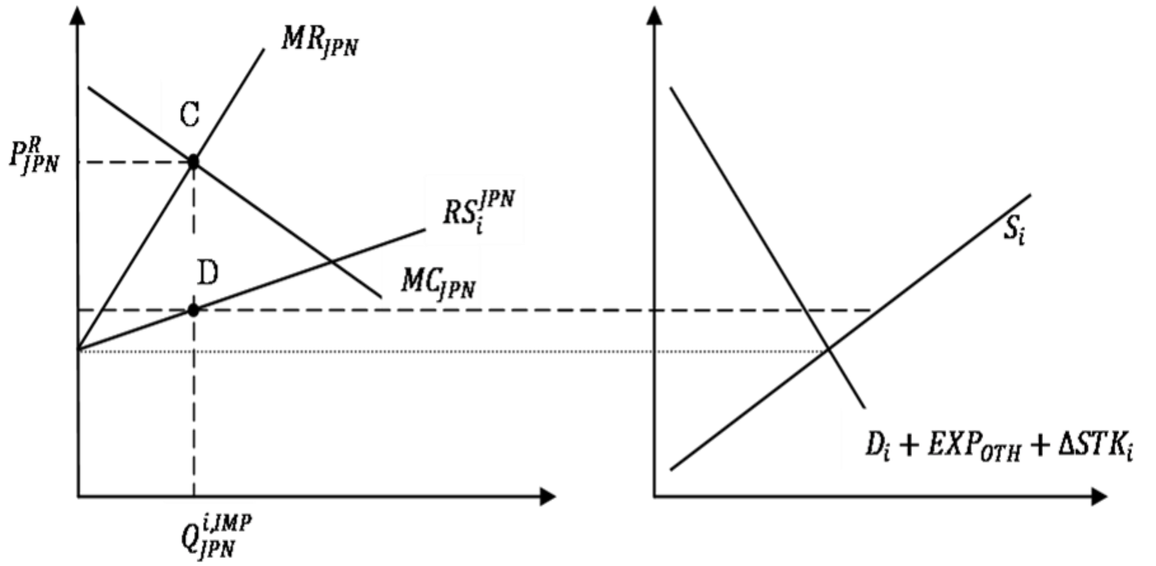
As shown in the left panel of Figure 3.2, the curve RS_i^{JPN} is the exporting country *i*'s residual Non-GM soybean supply for Japan which is equal to the exporting country *i*'s domestic supply, S_i, minus the cumulative demand in the right panel. This cumulative demand is the exporting country *i*'s domestic demand, D_i, plus exporting country *i*'s Non-GM soybean exports to countries other than Japan, EXP_{OTH}, plus the net change of Non-GM soybean stocks in exporting country *i*, ΔSTK_i. The curve MC_{JPN} and MR_{JPN} are the marginal cost and the marginal revenue for Non-GM soybean importers in Japan. For maximizing the Japanese Non-GM soybean importer profits, given the residual Non-GM soybean supply curve, Japanese Non-GM soybean importers choose point C in Figure 3.2, left panel, where the marginal cost equals the marginal revenue. Therefore, Japan's equilibrium import quantity is $Q_{JPN}^{i,IMP}$ at the equilibrium import price is $P_{JPN}^{i,IMP}$.

The Japanese Non-GM soybean importers choose to import quantity $Q_{JPN}^{i,IMP}$, to maximize their import profits, $\prod_{JPN}^{i}$.

$$\max_{Q_{JPN}^{i,IMP}} \prod_{JPN}^{i} = \frac{P_{JPN}^{R}}{E_{JPN}} * Q_{JPN}^{i,IMP} - \left[P_{JPN}^{i,IMP}\left(Q_{JPN}^{i,IMP}\right) + C_{JPN}\right] * Q_{JPN}^{i,IMP} \tag{18}$$

$\prod_{JPN}^{i}$ is the import profits obtained by the Japanese Non-GM soybean importers. Variable P_{JPN}^{R} is the Japanese domestic Non-GM soybean retail price. The variable $P_{JPN}^{i,IMP}$ is the Japanese Non-GM soybean import price from exporting country *i*, and $Q_{JPN}^{i,IMP}$ is the Japanese Non-GM soybean import quantity from exporting country *i*. The variable E_{JPN} is the exchange rate and C_{JPN} is the transaction costs paid by the Japanese soybean importers.

Figure 3.2 Exporting Country *i*'s Residual Non-GM Soybean Supply to Japan based on model's shown Song(2006)



Japanese Non-GM Soybean Imports --Exporting Country *i*'s Residual Non-GM Soybean Supply

i= the U.S., Canada, and China

Exporting Country *i*'s Domestic Non-GM Soybean Market

FOC of equation (18) gives:

$$\frac{\partial \prod^i_{JPN}}{\partial Q^{i,IMP}_{JPN}} = \frac{P^R_{JPN}}{E_{JPN}} - \left(\frac{\partial P^{i,IMP}_{JPN}}{\partial Q^{i,IMP}_{JPN}} * Q^{i,IMP}_{JPN} + P^{i,IMP}_{JPN} + C_{JPN} \right) = 0$$

$$\frac{P^R_{JPN}}{E_{JPN}} - P^{i,IMP}_{JPN} - C_{JPN} = \frac{\partial P^{i,IMP}_{JPN}}{\partial Q^{i,IMP}_{JPN}} * Q^{i,IMP}_{JPN}$$

$$\frac{\left(P^R_{JPN} / E_{JPN}\right) - P^{i,IMP}_{JPN} - C_{JPN}}{P^{i,IMP}_{JPN}} = \frac{\partial P^{i,IMP}_{JPN}}{\partial Q^{i,IMP}_{JPN}} * \frac{Q^{i,IMP}_{JPN}}{P^{i,IMP}_{JPN}} \tag{19}$$

Similar to equation (6), the left side of equation (19) measures the market power of the Japanese Non-GM soybean importers over Non-GM soybean exporters in country *i* as the Adjusted Lerner Index for Japan, ALI_{JPN}. It can be written as:

$$\frac{\left(P_{JPN}^{R} / E_{JPN}\right) - C_{JPN} - P_{JPN}^{i,IMP}}{P_{JPN}^{i,IMP}} = ALI_{JPN} \tag{20}$$

The right side of equation (20) is the price flexibility of the country *i*'s inverse residual Non-GM soybean supply for Japan. Therefore, the price flexibility of country *i*'s inverse residual Non-GM soybean supply for Japan can be used as an indirect measure to evaluate the market price of Non-GM soybean importers in Japan.

Equation (19) can be used to derive the relationship between the Japanese Non-GM soybean import price from exporting country *i* and the Japanese domestic Non-GM soybean retail price. Assuming that the Japanese Non-GM soybean importer's transaction costs are a constant ratio, γ_{JPN} , of the Japanese Non-GM soybean import price from exporting country *i*, it can be written as:

$$C_{JPN} = \gamma_{JPN} * P_{JPN}^{i,IMP} \tag{21}$$

and used to represent the price flexibility of exporting country *i*'s inverse residual supply for Non-GM soybeans for Japan as θ_{JPN}^{i} ,where:

$$\theta_{JPN}^{i} = \frac{\partial P_{JPN}^{i,IMP}}{\partial Q_{JPN}^{i,IMP}} * \frac{Q_{JPN}^{i,IMP}}{P_{JPN}^{i,IMP}} \tag{22}$$

Substituting equation (21) and (22) into (19), equation (19) can be written as:

$$\frac{\left(P_{JPN}^{R} / E_{JPN}\right) - P_{JPN}^{i,IMP} - \gamma_{JPN} * P_{JPN}^{i,IMP}}{P_{JPN}^{i,IMP}} = \theta_{JPN}^{i}$$

$$\frac{P_{JPN}^{R}}{E_{JPN}} = \theta_{JPN}^{i} * P_{JPN}^{i,IMP} + \gamma_{JPN} * P_{JPN}^{i,IMP} + P_{JPN}^{i,IMP}$$

$$P_{JPN}^{R} = \left(\theta_{JPN}^{i} + \gamma_{JPN} + 1\right) * E_{JPN} * P_{JPN}^{i,IMP} \tag{23}$$

and set:

$$\varphi_{JPN} = \left(\theta^{i}_{JPN} + \gamma_{JPN} + 1\right) * E_{JPN}$$

Then, equation (23) can be written as:

$$P^{R}_{JPN} = \varphi_{JPN} * P^{i,IMP}_{JPN} \tag{24}$$

Equation (24) shows the linear relationship between the Japanese Non-GM soybean import price from exporting country *i* and the Japanese domestic Non-GM soybean retail price.

As shown in Figure 3.2, exporting country *i*'s residual supply to Japan, RS_i^{JPN}, is equal to exporting country *i*'s domestic Non-GM soybean supply, S_i, minus exporting country *i*'s domestic Non-GM soybean demand, D_i, minus exporting country *i*'s Non-GM soybean exports to countries other than Japan, EXP_i^{OTH}, plus the net change of Non-GM soybean stocks in exporting country *i*, STK_i. Exporting country *i*'s residual Non-GM soybean supply function to Japan can be written as:

$$RS_i^{JPN} = S_i - \left(D_i + EXP_i^{OTH}\right) + \Delta STK_i \tag{25}$$

where exporting country *i*'s domestic demand and supply functions are:

$$D_i = D\left(P_i^{Farm}; Z_i^{D}\right) \tag{26}$$

$$S_i = S\left(P_i^{Farm}; Z_i^{S}\right) \tag{27}$$

and where the variable Z_i^D is a vector of demand shifters in exporting country *i* including income and population. P_i^{Farm} is the farm level Non-GM soybean price in exporting country *i*, and Z_i^S is a vector of supply shifters in country *i*, including production costs among others. Exporting country *i*'s Non-GM soybean exports to countries other than Japan and the net change of Non-GM soybean stocks in exporting country *i* are considered exogenous variables in this research.

Exporting country i's domestic demand and supply functions substitute into exporting country i's residual supply to Japan, thusly:

$$RS_i^{JPN} = RS\left(P_i^{Farm}; Z_i^S, Z_i^D, EXP_i^{OTH}, \Delta STK_i\right) \tag{28}$$

To consider the relationship between the Non-GM soybean export price for Japan and exporting country i's farm level price, Non-GM soybean price is substituted into exporting country i's residual Non-GM soybean supply function to Japan to obtain:

$$RS_i^{JPN} = RS\left(P_i^{EXP}; Z_i^S, Z_i^D, EXP_i^{OTH}, \Delta STK_i\right) \tag{29}$$

Writing the equation in inverse form, it becomes:

$$P_i^{EXP} = P_i^{EXP}\left(RS_i^{JPN}; Z_i^S, Z_i^D, EXP_i^{OTH}, \Delta STK_i\right) \tag{30}$$

Equation (30) is the exporting country i's inverse residual Non-GM soybean supply function for Japan.

Two-Country Partial Equilibrium Trade Model

A two-country partial equilibrium Non-GM soybean trade model for Japan can be written as:

$$\begin{cases} P_{JPN}^{i,IMP} = P_{JPN}^{i,IMP}\left(RD_{JPN}^{i}; Z_{JPN}^{D}, Z_{JPN}^{S}, IMP_{JPN}^{OTH}, \Delta STK_{JPN}\right) & (17) \\ P_i^{EXP} = P_i^{EXP}\left(RS_I^{JPN}; Z_i^S, Z_i^D, EXP_i^{OTH}, \Delta STK_i\right) & (30) \\ RD_{JPN}^{i} = RS_i^{JPN} & (31) \\ P_{JPN}^{i,IMP} = P_{JPN}^{i,IMP}\left(P_i^{EXP}\right) & (32) \end{cases}$$

where equation (17) is the Japanese inverse residual demand function for exporting country i's Non-GM soybeans. Equation (30) is exporting country i's Non-GM soybean inverse residual supply function to Japan. Equation (31) is the equilibrium condition where the Japanese Non-

GM soybean residual demand for exporting country *i* is equal to exporting country *i*'s Non-GM soybean residual supply to Japan. Equation (32) shows the relationship between the Japanese Non-GM soybean import price and exporting country *i*'s Non-GM soybean export price. This equation represents transportation and insurance costs by using CIF (Cost, Insurance, and Freight) price for the Japanese Non-GM soybean import price and FOB (Free on Board) price for exporting country *i*'s Non-GM soybean export price.

3.3 Variable Identification

Japanese Inverse Residual Non-GM Soybean Demand Model

The Japanese inverse residual Non-GM soybean demand function for exporting country *i* includes four groups of variables. The first group is the Japanese Non-GM soybean import quantity from exporting country *i* or the Japanese residual demand for country *i*'s Non-GM soybeans, RD^{i}_{JPN} . The second group is the Japanese domestic demand shifter, Z^{D}_{JPN} . In this research, the Japanese domestic demand shifter includes the Japanese personal disposable income, INC_{JPN} , and the time trend variable, *FT*. In this case, the time trend means food time trend where Japanese consumers Americanize their food over time. Americanized food uses less soybeans compared to Japanese traditional dishes. The third group is a Japanese Non-GM soybean supply shifter, Z^{S}_{JPN} . The fourth group includes Japanese Non-GM soybean imports from other countries, IMP^{OTH}_{JPN} , and Japanese Non-GM soybean stocks, STK_{JPN} . However, Japanese farmers produced few Non-GM soybean stocks during the research period, January 2003-December 2007. Accordingly, Japanese Non-GM soybean stocks are not included in this model.

The Japanese inverse residual Non-GM soybean demand for exporting country *i*'s specific functional form is written as:

$$P_{JPN}^{i,IMP} = \alpha_0 + \alpha RD_{JPN}^{i} + \alpha_1 INC_{JPN} + \alpha_2 IMP_{JPN}^{OTH} + \alpha_3 FT + \varepsilon_{JPN} \tag{33}$$

where,

$P_{JPN}^{i,IMP}$ is Japanese Non-GM soybean import price from exporting country *i*(￥/MT);

RD_{JPN}^{i} is Japanese residual demand for exporting country *i*'s Non-GM soybean (MT) or Japanese Non-GM soybean import quantity from exporting country *i*:

INC_{JPN} is Japanese personal disposable income ($);

IMP_{JPN}^{OTH} is Japanese Non-GM soybean imports from countries other than exporting country *i*(MT);

FT is the food time trend variable, measuring Americanization of Japanese dishes;

ε_{JPN} is the error term, assumed identically and independently distributed;

￥ is Japanese yen;

MT is Metric tons;

$ is U.S. dollars.

Exporting Country i's Inverse Residual Non-GM Soybean Supply Model

Similar to the Japanese inverse residual Non-GM soybean demand model, exporting country *i*'s inverse residual Non-GM soybean supply function for Japan includes five variable groups. The first group is exporting country *i*'s residual Non-GM soybean supply for Japan or the Non-GM soybean export quantity from country *i* to Japan, RS_i^{JPN}. The second group is the Non-GM soybean demand shifter in exporting country *i*, Z_i^D. Non-GM soybean demand shifter includes exporting country *i*'s personal disposable income, INC_i. The third group is the Non-GM soybean supply shifter for exporting country *i*, Z_i^S. Non-GM soybean supply shifter includes the time trend, *FT*. The fourth group is exporting country *i*'s Non-GM soybean exports to countries other than Japan, EXP_i^{OTH}. The fifth group is exporting country *i*'s Non-GM soybean beginning stocks, STK_i.

The specific functional form of exporting country *i*'s inverse residual Non-GM soybean supply model for Japan is written as:

$$P_i^{EXP} = \beta_0 + \beta RS_i^{JPN} + \beta_1 INC_i + \beta_2 EXP_i^{OTH} + \beta_3 STK_i + \varepsilon_i \qquad (34)$$

where,

P_i^{EXP} is exporting country *i*'s Non-GM soybean export price to Japan ($/MT);

RS_i^{JPN} is exporting country *i*'s residual Non-GM soybean supply for Japan or country *i*'s Non-GM soybean exports to Japan (MT);

INC_i is personal disposable income for exporting country *i*($);

EXP_i^{OTH} is Non-GM soybean exports from country *i* to countries other than Japan (MT);

STK_i is the beginning Non-GM soybean stocks in country *i*(MT);

ε_i is the error term, assumed identically and independently distributed.

Two-Country Partial Equilibrium Trade Model

Combining the Japanese inverse residual Non-GM soybean demand for exporting country *i* (equation 33), exporting country *i*'s inverse residual Non-GM soybean supply for Japan (equation 34) and establishing the equilibrium condition, where the Japanese inverse residual Non-GM soybean demand for exporting country *i* equals exporting country *i*'s inverse residual Non-GM soybean supply for Japan (equation 31), the specific functional form of the two-country partial equilibrium trade model is written as:

$$
\begin{cases}
P_{JPN}^{i,IMP} = \alpha_0 + \alpha RD_{JPN}^{i} + \alpha_1 INC_{JPN} + \alpha_2 IMP_{JPN}^{OTH} + \alpha_3 FT + \varepsilon_{JPN} & (33) \\
P_i^{EXP} = \beta_0 + \beta RS_i^{JPN} + \beta_1 INC_i + \beta_2 EXP_i^{OTH} + \beta_3 STK_i + \varepsilon_i & (34) \\
RD_{JPN}^{i} = RS_i^{JPN} & (31) \\
P_{JPN}^{i,IMP} = \phi_0 + \phi_1 P_i^{EXP} & (35)
\end{cases}
$$

The basic assumption of the two-country partial equilibrium trade model is the Japanese inverse residual Non-GM soybean demand for exporting country *i* and the exporting country *i*'s inverse residual Non-GM soybean supply for Japan are constant. With this assumption, using the double-log form, the coefficient estimated from the model is the price flexibility. The two-country partial equilibrium trade model equations can be estimated by the double-log form as shown in the following equation:

$$
\begin{cases}
LnP_{JPN}^{i,IMP} = \alpha_0 + \theta_{JPN}^{i} LnRD_{JPN}^{i} + \alpha_1 LnINC_{JPN} + \alpha_2 LnIMP_{JPN}^{OTH} + \alpha_3 FT + \varepsilon_{JPN} & (36) \\
LnP_i^{EXP} = \beta_0 + \theta_i^{JPN} LnRS_i^{JPN} + \beta_1 LnINC_i + \beta_2 LnEXP_i^{OTH} + \beta_3 LnSTK_i + \varepsilon_i & (37) \\
LnRD_{JPN}^{i} = LnRS_i^{JPN} & (38) \\
LnP_{JPN}^{i,IMP} = \phi_0 + \phi_1 LnP_i^{EXP} & (39)
\end{cases}
$$

Equations (36)-(39) represent the finalized specific functional form of the two-country partial equilibrium Non-GM soybean trade model.

3.4 Empirical Estimation and Interpretation

This research focuses solely on the U.S.-Japan partial equilibrium Non-GM soybean trade model since over seventy percent of the Non-GM soybeans consumed in Japan come from the U.S. Other Non-GM soybean exporting countries, Canada and China, are treated as other

Non-GM soybean exporters to Japan, IMP_{JPN}^{OTH} . Likewise, some European countries that import Non-GM soybeans from the U.S. are treated as other Non-GM soybean importers from the U.S., EXP_{US}^{OTH} .

The Japanese inverse residual demand for the U.S. Non-GM soybean model can be written as:

$$LnP_{JPN}^{US,IMP} = \alpha_0 + \theta_{JPN}^{US} LnRD_{JPN}^{US} + \alpha_1 LnINC_{JPN} + \alpha_2 LnIMP_{JPN}^{OTH} + \alpha_3 FT + \varepsilon_{JPN} \tag{40}$$

The U.S. inverse residual Non-GM soybean supply for Japan model can be written as:

$$LnP_{US}^{EXP} = \beta_0 + \theta_{US}^{JPN} LnRS_{US}^{JPN} + \beta_1 LnINC_{US} + \beta_2 LnEXP_{US}^{OTH} + \beta_3 LnSTK_{US} + \varepsilon_{US} \tag{41}$$

The U.S.-Japan partial equilibrium Non-GM soybean trade model is written as:

$$\begin{cases} LnP_{JPN}^{US,IMP} = \alpha_0 + \theta_{JPN}^{US} LnRD_{JPN}^{US} + \alpha_1 LnINC_{JPN} + \alpha_2 LnIMP_{JPN}^{OTH} + \alpha_3 FT + \varepsilon_{JPN} & (40) \\ LnP_{US}^{EXP} = \beta_0 + \theta_{US}^{JPN} LnRS_{US}^{JPN} + \beta_1 LnINC_{US} + \beta_2 LnEXP_{US}^{OTH} + \beta_3 LnSTK_{US} + \varepsilon_{US} & (41) \\ LnRD_{JPN}^{US} = LnRS_{US}^{JPN} & (42) \\ LnP_{JPN}^{US,IMP} = \phi_0 + \phi_1 LnP_{US}^{EXP} & (43) \end{cases}$$

Data Description

For estimating the U.S.-Japan partial equilibrium Non-GM soybean trade model, monthly data from January 2003 to December 2007, 60 observations in all, were used. See Table 3.1 for all variables used in this analysis and sources.

Table 3.1 The U.S.-Japan Partial Equilibrium Non-GM Soybean Trade Model's Variables and Sources

Variable	Meaning	Source
$P_{JPN}^{US,IMP}$	Japanese Non-GM soybean import price from US (¥/MT)	USDA-FAS
RD_{JPN}^{US}	Japanese residual demand for U.S. Non-GM soybean (MT)	Ministry of Finance Japan Shokuhin Sangyou Shinbunsha Co., Ltd.
INC_{JPN}	Japanese personal disposable income ($)	USDA-ERS
IMP_{JPN}^{OTH}	Japanese Non-GM soybean imports from Canada and China (MT)	Ministry of Finance Japan Shokuhin Sangyou Shinbunsha Co., Ltd.
P_{US}^{EXP}	U.S. Non-GM soybean export price to Japan ($/MT)	USDA-FAS
RS_{US}^{JPN}	U.S. Non-GM soybean residual supply for Japan (MT)	Ministry of Finance Japan Shokuhin Sangyou Shinbunsha Co., Ltd.
INC_{US}	U.S. personal disposable income ($)	USDA-ERS
EXP_{US}^{OTH}	U.S. Non-GM soybean exports to other countries (MT)	USDA-FAS
STK_{US}	U.S. Non-GM soybean beginning stocks (MT)	USDA-ERS

Data for the Japanese inverse residual Non-GM soybean demand, RD_{JPN}^{US}, and the U.S. inverse residual Non-GM soybean supply, RS_{US}^{JPN}, were obtained from the Ministry of Finance Japan (2008) and *Daily Soybean and Oil Seeds* published by Shokuhin Sangyou Shinbunsha Co., Ltd. (Food Industry Newsweek Co., Ltd.). The amount of monthly Non-GM soybean in Japan imported from the U.S. for each month, $SB_{JPN,M}^{US,NGM}$, is the amount of monthly soybean imported by Japan from the U.S., $SB_{JPN,M}^{US}$, divided by the amount of soybeans Japan imported yearly from the

U.S., $SB_{JPN,Y}^{US}$, multiplied by the Non-GM soybeans imported by Japan yearly from the U.S., $SB_{JPN,Y}^{US,NGM}$. It can be written as:

$$SB_{JPN,M}^{US,NGM} = \frac{SB_{JPN,M}^{US}}{SB_{JPN,Y}^{US}} * SB_{JPN,Y}^{US,NGM} \tag{44}$$

Japanese personal disposable income, INC_{JPN}, is from the U.S. Department of Agriculture, Economics Research Service (USDA-ERS) International Macroeconomic Data Set (USDA-ERS, 2008b). According to Song (2006), the U.S. personal disposable income and Japanese personal disposable income are annual data. In this research, however, monthly data is required. Personal disposable income for the U.S. and Japan were transformed into monthly format, as described below. First, the annual growth rate of Japanese personal disposable income was calculated. Second, the initial value was set as the January disposable income. Then, the calculated annual growth rate and the initial value were used to estimate disposable income for the remaining months of the year. The last step was to use the trial-and-error method to adjust the January income so that the sum of the estimated monthly disposable incomes equaled the actual annual disposable income. The estimated monthly income was used to approximate the actual monthly disposable income in the empirical estimation (Song 2006).

The variable, Japanese Non-GM soybean imports from other countries, IMP_{JPN}^{OTH}, was calculated from data obtained from the Ministry of Finance Japan (2008) and *Daily Soybean and Oil Seeds*, published by Shokuhin Sangyou Shinbunsha Co., Ltd. The variable IMP_{JPN}^{OTH} is the sum of the monthly Japanese soybean imports from Canada and China multiplied by the amount of yearly Japanese Non-GM soybean imports from Canada and China, $SB_{JPN,Y}^{OTH,NGM}$. The amount of monthly Japanese soybean imports from Canada where the sum of the amount of Japanese soybean imports from Canada and China equals 100, is the amount of monthly Japanese soybean imports from Canada, $SB_{JPN,M}^{CA}$; divided by the amount of yearly Japanese soybean imports from Canada, $SB_{JPN,Y}^{CA}$; multiplied by the yearly Canada to China soybean import to Japan ratio, $\left(\frac{SB_{JPN,Y}^{CA}}{SB_{JPN,Y}^{CA}+SB_{JPN,Y}^{CH}}*100\right)$. The monthly Japanese soybean imports from Canada can be written as:

$$\frac{SB_{JPN,M}^{CA}}{SB_{JPN,Y}^{CA}}*\left(\frac{SB_{JPN,Y}^{CA}}{SB_{JPN,Y}^{CA}+SB_{JPN,Y}^{CH}}*100\right) \tag{45}$$

Similarly, the amount of monthly Japanese soybean imports from China when the sum of the amount of Japanese soybean imports from Canada and China equals 100, is the amount of monthly Japanese soybean imports from China, $SB_{JPN,M}^{CH}$; divided by the amount of yearly Japanese soybean imports from China, $SB_{JPN,Y}^{CH}$; multiplied by the yearly Chinese soybean ratio in Japan, which is 100 minus the yearly Canada to China soybean import to Japan ratio. The monthly Japanese soybean imports from China can be written as:

$$\frac{SB_{JPN,M}^{CH}}{SB_{JPN,Y}^{CH}}*\left[100-\left(\frac{SB_{JPN,Y}^{CA}}{SB_{JPN,Y}^{CA}+SB_{JPN,Y}^{CH}}*100\right)\right] \tag{46}$$

Thus, Japanese Non-GM soybean imports form Canada and China can be written as:

$$\begin{aligned} IMP_{JPN}^{OTH} = \Bigg\{ & \left[\frac{SB_{JPN,M}^{CA}}{SB_{JPN,Y}^{CA}}*\left(\frac{SB_{JPN,Y}^{CA}}{SB_{JPN,Y}^{CA}+SB_{JPN,Y}^{CH}}*100\right)\right] \\ & +\left[\frac{SB_{JPN,M}^{CH}}{SB_{JPN,Y}^{CH}}*\left(100-\left(\frac{SB_{JPN,Y}^{CA}}{SB_{JPN,Y}^{CA}+SB_{JPN,Y}^{CH}}*100\right)\right)\right]\Bigg\}*SB_{JPN,Y}^{OTH,NGM} \end{aligned} \tag{47}$$

For the U.S. inverse residual Non-GM soybean supply to Japan model, the U.S. Non-GM soybean export price to Japan, P_{US}^{EXP}, is the FOB price reported by the U.S. Department of Agriculture, Foreign Agriculture Service (USDA-FAS, 2008). The U.S. personal disposable income, INC_{US}, is from USDA-ERS, International Macroeconomic Data Set (USDA-ERS, 2008b). Similar to the Japanese personal disposable income, the reported data for U.S. personal disposable income is annual data. Using the same method as used for the Japanese personal disposable income, U.S. monthly personal disposable income is estimated from the actual annual income.

The variable U.S. Non-GM soybean beginning stocks, STK_{US}, was obtained from the USDA-ERS, Oil Crops Yearbook (USDA-ERS, 2008c).

The variable U.S. Non-GM soybean exports to countries other than Japan, EXP_{US}^{OTH}, is calculated using data obtained from USDA-FAS. The variable EXP_{US}^{OTH}, is the amount of monthly U.S. Non-GM soybean exports, EXP_{US}^{NGM}; minus the amount of monthly U.S. Non-GM soybean exports to Japan, EXP_{US}^{JPN}. The amount of monthly U.S. Non-GM soybean exports, EXP_{US}^{NGM}; is the amount of monthly U.S. soybean exports, $EXP_{US,M}$; multiplied by the Non-GM soybean to GM soybean cropping ratio in the U.S. which is 1 minus the percentage of GM soybean cropping ratio in the U.S., $\left(1-\%SB_{area}^{GM}\right)$; divided by twelve.

$$EXP_{US}^{OTH} = EXP_{US}^{NGM} - EXP_{US}^{JPN} \tag{48}$$

$$EXP_{US}^{NGM} = \frac{EXP_{US,M}}{12} * \left(1-\%SB_{area}^{GM}\right) \tag{49}$$

Specification Test

Before estimating the U.S.-Japan two-country partial equilibrium Non-GM soybean trade model, a heteroscedasticity test was conducted for both Japanese inverse residual demand function for the U.S. Non-GM soybeans and the U.S. inverse residual Non-GM soybean supply function for Japan.

Heteroscedasticity

White's test (White 1980) was used to test for heteroscedasticity problems for both the Japanese inverse residual demand function for U.S. Non-GM soybeans and the U.S. inverse residual Non-GM soybean supply function for Japan. The residuals of estimation were used to investigate the heteroscedasticity of the true disturbances. The null hypothesis for White's test is

$H_0 : \sigma_i^2 = \sigma^2$ for all *i*.

In Table 3.2, test results indicate that the null hypothesis for equation (40) and (41) cannot be rejected for either model. These test results imply that neither the Japanese inverse residual demand function nor the U.S. inverse residual supply function have a heteroscedasticity problem.

Table 3.2 White's Test Results for Heteroscedasticity

	White's Test	Critical Value	Pr>ChiSp	Result
Japanese inverse residual demand function for the U.S. Non-GM soybeans (equation 40)	11.30	27.2	0.5854	Fail to reject
The U.S. inverse residual Non-GM soybean supply function for Japan (equation 41)	11.41	27.2	0.3300	Fail to reject

Estimation and Interpretation

The U.S.-Japan two-country partial equilibrium Non-GM soybean trade model was simultaneously estimated by using the SAS Three-Stage Least Squares (3SLS) method. Estimated results, reported in Table 3.3, show that for the Japanese inverse residual demand function (40), Japanese residual Non-GM soybean demand, RD_{JPN}^{US}, is statistically significant at the 1% level.

Table 3.3 Estimated Results of the U.S.-Japan Partial Equilibrium Trade Model

	Variable	Coefficient	Standard Error	t Value	Pr > |t|
Japanese Inverse Residual Non-GM Soybean Demand: $P_{JPN}^{IMP} = P\left(RD_{JPN}^{US},...\right)$	*Intercept*	18.60854*	4.591843	4.05	0.0002
	RD_{JPN}^{US}	-0.21955*	0.091787	-2.39	0.0102
	INC_{JPN}	-0.57598	0.405074	-1.42	0.1607
	IMP_{JPN}^{OTH}	0.008464	0.031475	0.27	0.7890
	FT	0.036404	0.039466	0.92	0.3603
U.S. Inverse Residual Non-GM Soybean Supply: $P_{US}^{EXP} = P\left(RS_{US}^{JPN},...\right)$	*Intercept*	3.148397*	3.516505	0.90	0.0045
	RS_{US}^{JPN}	0.040696*	0.215060	0.19	0.0068
	INC_{US}	0.662107	0.439792	1.51	0.1379
	EXP_{US}^{OTH}	-0.06222	0.051102	-1.22	0.2286
	STK_{US}	-0.03522**	0.018298	-1.92	0.0594
Price Relationship $P_{JPN}^{IMP} = P\left(P_{US}^{EXP}\right)$	*Intercept*	5.624331*	0.392903	14.31	<.0001
	P_{US}^{EXP}	0.846458*	0.067456	12.55	<.0001

Note: * 1% significant level, ** 10% significant level.

The sign of the estimated coefficient of the Japanese residual Non-GM soybean demand, RD_{JPN}^{US}, is negative as expected, indicating a downward sloping Japanese residual demand for U.S. Non-GM soybeans. By equation (40), the estimated coefficient is also the price flexibility of the Japanese residual demand function for U.S. Non-GM soybeans, equaling the Adjusted Lerner Index of the U.S., ALI_{US}, which can be used to measure the market power of the U.S. Non-GM soybean exporters as shown by equation (5), (6), and (8). From another perspective, the estimated coefficient also indicates the profit earned by U.S. Non-GM soybean exporters (the difference between the U.S. Non-GM soybean export price, the sum of the U.S. farm level soybean prices, and the U.S. Non-GM soybean exporters' transaction costs). Estimated results indicate that the market profits of the U.S. Non-GM soybean exporters are 22% of the U.S. farm level Non-GM soybean price in Table 3.3.

For the U.S. inverse residual Non-GM soybean supply function (equation 41), the U.S. residual Non-GM soybean supply, RS_{US}^{JPN}, is statistically significant at the 1% level as shown in Table 3.3. The sign of the parameter for the U.S. residual Non-GM soybean supply for Japan, RS_{US}^{JPN}, is positive as expected, indicating an upward sloping U.S. residual Non-GM soybean supply curve.

By equation (41), the estimated coefficient for the U.S. Non-GM soybean residual supply quantity, RS_{US}^{JPN}, is also the price flexibility of the U.S. inverse residual Non-GM soybean supply function for Japan, which is also the Adjusted Lerner Index for Japan, ALI_{JPN} by equation (19), (20) and (22) which can be used to measure the market power of the Japanese Non-GM soybean importers. From another perspective, the left hand side of equation (19), the estimated coefficient, indicates the profits of Japanese Non-GM soybean importers (the difference between the

Japanese domestic Non-GM soybean price, the Japanese Non-GM soybean import price from the U.S., and the Japanese Non-GM soybean importers' transaction costs). Estimated results indicate that the market profits of Japanese Non-GM soybean importers are 4% of the U.S. Non-GM soybean import price in Table 3.3.

Table 3.4 summarizes the above discussion. The estimated price flexibility of the Japanese inverse residual demand for the U.S. Non-GM soybeans is -0.219 and the market profits of the U.S. Non-GM soybean exporters (the difference between the U.S. Non-GM soybean export price and the sum of the U.S. farm level Non-GM soybean prices and the transaction costs of the U.S. Non-GM soybean exporters) are about 22% of the export price. Similarly, the estimated price flexibility of the U.S. inverse residual Non-GM soybean supply to Japan is 0.04 and the market profits of Japanese Non-GM soybean importers are about 4% of the Non-GM soybean import price as shown in Table 3.4. Comparing these two coefficients, it can be inferred that U.S. Non-GM soybean exporters have greater market power than Japanese Non-GM soybean importers.

Table 3.4 The Comparison of the Estimated Model Results

Model	Coefficient	Standard Error	t Value	Pr > |t|
Japanese Inverse Residual U.S. Non-GM Soybean Demand: $P_{JPN}^{IMP} = P(Q_{JPN}^{IMP},...)$	-0.22*	0.091787	-2.39	0.0102
U.S. Inverse Residual Non-GM Soybean Supply to Japan: $P_{US}^{EXP} = P(Q_{US}^{EXP},...)$	0.04*	0.215060	0.19	0.0068

Note: * 1% significant level.

CHAPTER 4 - Conclusions

Conclusions

People around the world have recently become more interested in food-related health issues. The Japanese people have long been concerned about healthy food. One of the most popular Japanese health foods is tofu produced from soybeans. However, Japan grows only about 10% of the soybeans consumed in the country each year. Japan imports about 70% of its food soybean needs from the U.S. In recent years, the U.S. soybean farmers have switched from producing all Non-GM soybeans to producing almost all GM soybeans. At present, only nine percent of the U.S. soybean crop remains Non-GM soybeans. Soybean producers in other countries are following the U.S. example and are switching to GM soybeans. GM soybeans have lowered production costs while raising yields for soybean producers. In the future, differential incentives for farmers to grow Non-GM soybeans will have to increase to offset lower yields, higher production costs, and the costs associated with segregating Non-GM soybeans from GM soybeans.

By the late 1990's, Japanese people had developed widespread apprehension about the safety of consuming GM soybeans. Since then, they have insisted on eating only Non-GM soybeans. In response to consumer desires, Japanese soybean importers only import Non-GM soybeans for food soybeans in Japan. This makes the Japanese food soybean market unique in the world.

Market power is defined in this paper to mean the ability of a seller to negotiate the market price of a product and other terms of trade in his favor. With the decline in Non-GM soybean production in the U.S. Canada, and China, it appears that market power in the Japanese food soybean market has shifted to the sellers of Non-GM soybeans. By assuming that Japan is a single buyer of Non-GM soybeans, it can be hypothesized that the Japanese Non-GM soybean import market is a monopsony. Selling countries, the U.S., Canada, and China, on the other hand, can be seen as oligopolists. The question then becomes which has the greater market power-the monopsonistic buyer; Japan, or the oligopolistic sellers; the U.S., Canada, and China.

A two-country partial equilibrium trade model was constructed to test the hypothesis that market power has shifted to the sellers of Non-GM soybeans. The U.S.-Japan partial equilibrium trade model showed that U.S. Non-GM soybean exporters have relatively stronger market power than Japanese Non-GM soybean importers. The market margin for U.S. Non-GM soybean exporters was estimated at 22% of the export price. Conversely, the market margin for the Japanese Non-GM soybean importers was only about 4% of the Non-GM soybean import price. These results show that the Japanese importers may have to pay a higher price to purchase Non-GM soybeans in the future. It also indicates that Japanese consumers will have to pay higher prices for tofu, natto, miso, and other soy foods. The long term implication of the difference in market power is Japanese Non-GM soybean importers will purchase more Non-GM soybeans from Canada or China, or select inexpensive soybeans such as U.S. GM soybeans near future. Eventually, Japanese consumers will have to make a decision to keep paying a higher price for Non-GM soybeans or accept lower priced GM soybeans.

Future Research

The data necessary to include Canada and China in the analysis were not available. If and when such data does become available, the two-country partial equilibrium trade models for China-Japan and Canada-Japan can be developed and empirically tested. To examine the Japanese Non-GM soybean food industries in greater depth, costs models must be developed to test micro economic issues. In addition, the two-country partial equilibrium soybean trade model for the U.S.-Japan can be adjusted and applied to the U.S.-Japan GM soybean trade when Japanese soybean importers start to import GM soybeans for human food soybean consumption.

References

American Soybean Association-International Marketing Japan (ASA-IM Japan). *Handling Bulk and Identity Preserved US Soybeans*, 2007.

ASA-IM Japan. *JAPANESE FOOD BEAN MARKET*. Website: http://www.asajapan.org/food/foodbean/index.html, last accessed in February 2008, (In Japanese).

ASA-IM Japan. *IP handling systems*. Website: http://www.asajapan.org/food/ip/index.html, last accessed in November 2007, (In Japanese).

American Soybean Association-International Marketing Korea (ASA-IM Korea). Website: http://www.asa-im.or.kr/index.asp, last accessed in December 2007, (In Korean).

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

Chen, P., Developing High-Quality Identity-Preserved Soybeans for the Specialty Soyfood Market, *International Buyer's Guide,* The United States Soybean Export Council, Chapter three, 2006.

Food and Agriculture Organization of the United Nations (FAO). *Online statistics databases (FAOSTAT)*. Website: http://faostat.fao.org/site/535/default.aspx, last accessed in February 2008.

Fukunaga, K. "The role of trust in US-Japanese food-grade soybean transactions." Masters Thesis, Iowa State University, 2003.

Goldberg, Pinelopi K., and Michael M. Knetter, "Measuring the Intensity of Competition in Export Markets," Journal of International Economics 47 (February 1999), 27-60. International Monetary Fund (IMF), *Data and Statistics*. Website: http://www.imf.org/external/data.htm, last accessed in February 2008.

Illinois Specialty Farm Products, *Specialty Soybeans Markets*. Website: http://web.aces.uiuc.edu/Value/markets/soy/default.pdl, last accessed in November 2007.

Kiyono, S. "Tofu Food Chain and Its Structural Change." *Bulletin of the Department of Food Economics*, Nihon University, No.20, 1992, (In Japanese).

Kondoh, A., "The Production, Consumption, and Import Demand for Soybeans in Japan with Emphasis on the Potential of U.S. Soybean Export Expansion." Masters Thesis, Mississippi State University, 1991.

Lerner, A., "The concept of monopoly and the measurement of monopoly power." *Review of Economics Studies* 1, 157-175, 1934.

The Ministry of Agriculture, Forestry, and Fishery of Japan (MAFF), *Data: self-sufficiency by items of major industrial countries,* 2006. Website: http://www.toukei.maff.go.jp/world/index.html, last accessed in February 2008, (In Japanese).

MAFF, 2003. *Data: self-sufficiency in grains of major industrial countries*, 2003. Website: http://www.maff.go.jp/j/zyukyu/zikyu_ritu/013.html, last accessed in February 2008, (In Japanese).

MAFF, 2006. "values and problems of tackling increasing self-sufficiency ratio." *Shokuryo, Nougyo and Nouson Hakusho (White paper on Foods, Agriculture and farm village)*, Chapter 1.1, 2006, (In Japanese).

Ministry of Finance Japan, Japan Customs, Trade Statistics of Japan, *Online statistics databeses*. Website: http://www.customs.go.jp/toukei/info/tsdl.htm, last accessed in February 2008, (In Japanese).

MISO ONLINE, *Knowledge of Miso*, 2007. Website: http://www.miso.or.jp/dictionary/history/index.html, last accessed December 2007, (In Japanese).

The Japan Agricultural News, Inc., *Decrease in U.S. Non-GM soybean production,* 2007. Website: http://www.nougyou-shimbun.ne.jp/modules/bulletin1/index.php, last accessed August 2007.

Norris, G., "Soy demand rising with concern about health issues, environment" Published Government Information Office, Republic of China. Website http://publish.gio.gov.tw/FCJ/past/06010681.html, last accessed August 2007.

SAS Institute Inc. *SAS OnlineDoc®*, Version 9.1.3, 2007.

Shokuhin Sangyou Shinbunsha Co., Ltd., *Daily Soybean and Oil Seeds*. 2005, (In Japanese).

Shokuhin Sangyou Shinbunsha Co., Ltd., *Daily Soybean and Oil Seeds*. 2006, (In Japanese).

Shokuhin Sangyou Shinbunsha Co., Ltd., *Daily Soybean and Oil Seeds*. 2007, (In Japanese).

Song, B., "Market Power and Competitive Analysis of China's Soybean Import Market" Dissertation, University of Kentucky, 2006.

U. S. Department of Agriculture, Economic Research Service (USDA-ERS), 2008. *Briefing Rooms: Soybeans and Oil Crops: Data Tables*. Website: http://www.ers.usda.gov/briefing/SoybeansOilCrops/data.htm, last accessed in February 2008.

USDA-ERS, 2008a. *Briefing Rooms: Soybeans and Oil Crops: Soybeans and Oil Crops: Recommended Readings*. Website: http://www.ers.usda.gov/Briefing/SoybeansOilCrops/recommendedreadings.htm#outlook last accessed in February 2008.

USDA-ERS, 2008b. Data: international macroeconomic data set (Online), 2008. Website: http://www.ers.usda.gov/Data/macroeconomics/, last accessed in March 2008.

USDA-ERS, 2008c. Publications: *Oil Crops Yearbook from 2002-2007*, Washington, DC. Website: http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1290, last accessed March 2008.

USDA-Economic, Statistics, and Market Information System (USDA-ESMIS), 2008. National Agricultural Statistics Service (NASS), *Agricultural Prices* 2008. Website: http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1002, last accessed in March 2008.

U.S. Department of Agriculture, Foreign Agriculture Service (USDA-FAS), 2008. U.S. Trade Internet System. Washington, DC. Website: http://www.fas.usda.gov/ustrade/, last accessed in March 2008.

The United States Soybean Export Council (USSEC), Transporting U.S. Soybeans to Export Markets, *International Buyer's Guide,* The United States Soybean Export Council, Chapter Four, 2006.

White, Halbert (1980). "A Heteroskedasticity-Consistant Covariance Matrix Estimator and a Direct Test for Heteroskedasticity." *Econometrica*, 48(4), 817—838, 1980.

Zentouren, *ABOUT TOFU*, 2006. Website: http://www.zentoren.jp/info/08.html, last accessed in November 2007, (In Japanese).