MARKET POWER AND COMPETITIVE ANALYSIS OF CHINA'S SOYBEAN IMPORT MARKET

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ABSTRACT OF DISSERTATION

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MARKET POWER AND COMPETITIVE ANALYSIS OF CHINA’S SOYBEAN IMPORT MARKET

ABSTRACT OF DISSERTATION

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the College of Agriculture at the University of Kentucky

By

Baohui Song

Lexington, Kentucky

Director: Dr. Mary A. Marchant, Professor of Agricultural Economics

Lexington, Kentucky

2006

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ABSTRACT OF DISSERTATION

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Globally, China is the number one soybean importer, and the United States, Brazil, and Argentina are the top three soybean exporters. This research, based on the reverse residual demand model, developed and estimated a two-country partial equilibrium trade model to test who has stronger market power in the Chinese soybean import market. This two-country partial equilibrium trade model incorporates the U.S. residual soybean supply for China, the Chinese residual demand for U.S. soybeans, and the equilibrium condition, where the U.S. residual soybean supply equals the Chinese residual soybean demand. Data used in this research are monthly data from January 1999 to February 2005, 74 observations. Empirical results indicated that Chinese soybean importers have stronger market power relative to U.S. soybean exporters.

This research also conducted the competitive analysis of the Chinese soybean import market by examining both annual and monthly data of Chinese soybean imports from the U.S. and South America (Brazil and Argentina). Results implied that the U.S. and South America are seasonal complementary soybean suppliers for China. Possible reasons include: 1) seasonal difference—the U.S. and South America have opposing growing seasons, i.e., different time periods to supply soybeans to markets; and 2) stronger market power of Chinese soybean importers—China’s strategic choice, diversifying their soybean suppliers and reducing price increase risk, made the U.S. and South America complementary soybean suppliers to China.

Additionally, this research compared the soybean export costs to China for the three countries. Results showed that Brazil has the greatest advantage for production costs, followed by Argentina and the U.S.; the U.S. has the greatest advantage for internal and international transportation and marketing costs, followed by Argentina and Brazil. In aggregate, the total soybean export costs for Brazil were the lowest and the export costs for Argentina were the highest, with U.S. costs between them.
In terms of policy implications for the U.S. soybean industry facing strong competition from South America, we cannot expect that U.S. market share in the Chinese soybean import market can be expanded much. With the development of infrastructure in Brazil and Argentina, the U.S. advantage will become less and less. Therefore, if the U.S. soybean industry wants to keep its current position in the Chinese soybean import market, some governmental policy supports are still necessary.

**KEYWORDS:** Chinese Soybean Import Market, Competitive Analysis, Market Power, Two-Country Partial Equilibrium Trade Model, Soybean Policies

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CHAPTER ONE
INTRODUCTION

Background

From a global perspective, soybeans are among the top five agricultural commodities in harvested area—wheat, rice, corn, soybeans, and barley. As shown in Figure 1, in 2004 the harvested area for soybeans reached 92 million hectares, ranking fourth (FAO, 2005). Among these five commodities, the international trade ratio (export volume divided by production) for soybeans was highest, followed by wheat, barley, corn, and rice. Figure 2 shows that after 2000, about 30% of soybeans were traded on the world market (FAO, 2005). This fact implies that international trade for soybeans is crucial for and of interest to both soybean exporting and importing countries.

Figure 1. The Top Five Agricultural Commodities in the World (Harvested Area)
From a production perspective, the U.S., Brazil, Argentina, and China are the top four soybean producers in the world. The sum of soybean production from these four countries accounted for 90% of the world total in 2004, with the U.S. at 39%, Brazil at 25%, Argentina at 18%, and China at 8% (USDA-FAS, 2006b). In addition, the U.S., Brazil, and Argentina were also the top three global soybean exporters, and the sum of soybean exports from these three countries accounted for 92% of the world total in 2004, with the U.S. at 46%, Brazil at 32%, and Argentina at 15%.

From an import perspective, the top four soybean importing countries are China, the European Union (EU), Japan, and Mexico. The sum of soybean imports from these...
four countries accounted for 76% of the world total, with China at 40%, the EU at 24%, Japan at 7%, and Mexico at 6% in 2004.

The U.S. leads the world in soybean production, consumption, and exports. However, in the last decade, soybean industries in Brazil and Argentina developed very quickly and became strong competitors for the U.S. in the world soybean market. Excess supply of soybeans from the U.S., Brazil, and Argentina increased quickly in recent years. To deal with this soybean surplus, Chinese soybean import market became a primary consideration. Although China is a large soybean producer, China is also the number one soybean importer in the world. Excess soybean demand by China skyrocketed in the last decade. With 1.3 billion people, rapid economic growth, and rapid development of the livestock industry, the Chinese soybean demand is expected to continue to increase, as a main source of food oil for human consumption and feed for livestock. In contrast, excess soybean demand by other main soybean importers, including the EU, Japan, and Mexico, have been quite stable. Therefore, China will continue to play a key role in the world soybean market.

Objectives of Research

Given the above facts, the Chinese soybean import market can be characterized as either monopsony, whereby Chinese soybean importers have stronger market power relative to soybean exporters, including the U.S., Brazil, and Argentina, or oligopoly, whereby these three soybean exporters have stronger market power relative to Chinese soybean importers. Knowing who has stronger market power is of interest to both soybean exporting countries and soybean importing countries, especially the United
States since soybeans are the United States’ number one bulk export commodity.

Although the U.S. is currently the leader of the global soybean industry, the rapid development of Brazilian and Argentinean soybean industries is threatening this leading position.

To enhance competitiveness of the U.S. soybean industry and to expand U.S. market share in the Chinese soybean import market, knowing the market position and competitive status of these three main soybean suppliers for China is crucial for the U.S. soybean industry to make production and marketing decisions, and for U.S. policymakers to formulate soybean policies. As the former secretary of the U.S. Department of Agriculture (USDA), Ann Veneman (2003), said

"One of the key objectives set forth in the Department’s new strategic plan is the expansion of international marketing opportunities. As the strategic plan and our earlier review of the U.S. food and agricultural system in the 21st century make clear, expanding markets is critical to the long-term health and prosperity of American agriculture. With 96 percent of the world’s population living outside the United States, future growth in demand for food and agricultural products will occur primarily in overseas markets” (Veneman, 2003).

The objectives of this research include

(1) To provide a global outlook of the soybean industry;

(2) To review soybean policies and their impacts on soybean production, exportation, and importation for soybean exporting and importing countries;

(3) To develop a two-country partial equilibrium trade model and apply this model to test market power for the Chinese soybean import market;
To analyze the competitive structure of these top three soybean suppliers—the United States, Brazil, and Argentina—in the Chinese soybean import market.

**Organization of the Dissertation**

This dissertation is divided into nine chapters. Chapter one introduces the background, objectives, and organization of this dissertation. Chapter two provides an outlook of the global soybean industry. In this chapter, abundant data and figures draw a clear picture of the world soybean industry, including the leading soybean producing and consuming countries along with exporting and importing countries. Chapter three reviews soybean policies and their impacts on soybean production and exports from the U.S., Brazil, and Argentina, as well as their biotech policies and impacts on soybean exports into China.

Chapter four reviews the literature, including the Lerner Index, which is a primary concept to measure market power, the price to market model (PTM), which focuses on the impacts of the exchange rates on import prices, and the residual demand elasticity model, which was commonly used in the literature to empirically test market power. Finally, a review of research on the soybean industry includes the International Oilseed Model developed by the Food and Agricultural Policy Research Institute (FAPRI) in the Center for Agricultural and Rural Development (CARD), and the U.S. Department of Agriculture, Economic Research Service (USDA-ERS)/Penn State Trade Model.

Chapters five, six, and seven develop and estimate the model, including derivation of the theoretical model (Chapter five), variable identification (Chapter six), and empirical estimation and interpretation (Chapter seven). Based on the results from
Chapter seven, Chapter eight conducts additional competitive analysis of the Chinese soybean import market. The last chapter, Chapter nine, is discussion and conclusions.
CHAPTER TWO
OUTLOOK OF THE WORLD SOYBEAN INDUSTRY

Leading Global Soybean Producers

Global harvested area for soybeans increased steadily from 26 million hectares (63 million acres) in 1964 to 92 million hectares (226 million acres) in 2004 (Figure 3; FAO, 2005). During this period (1964-2004), the average annual growth rate of the global harvested area for soybeans was 3%.

![Figure 3. Global Harvested Area for Soybeans](source)


Among global soybean producers, the top four countries are the U.S., Brazil, Argentina, and China, as shown in Figure 4. In 2005, soybean output from these four countries reached 200 million metric tons, accounting for 90% of the global total (USDA-FAS, 2006b). Among them, the U.S. led the world in soybean production with an output
of 84 million metric tons in 2005. Brazilian soybean output reached 57 million metric tons, about 76% of U.S. production, and ranked second in the world. Argentina produced 41 million metric tons of soybeans and China only produced 18 million metric tons.

![Leading Global Soybean Producing Countries](image)

Figure 4. Leading Global Soybean Producing Countries

Source: USDA-FAS, 2006b.

Figure 4 also indicates that the growth of soybean production was quite stable for the U.S., China, and other countries. In the last four decades, the average annual growth rates of soybean production in the U.S. and China were 5% and 3%, respectively. In contrast, soybean production in Brazil and Argentina increased dramatically in recent years. From 1964 to 2005, the average annual growth rates of soybean production in Brazil and Argentina were 14% and 27%, respectively (USDA-FAS, 2006b). From these trends shown in figure 4, it is reasonable to expect that within a few years Brazil may surpass the U.S. and become the largest soybean producer in the world, if Brazil continues its current growth rate. In contrast, the growth rate of Argentinean soybean
production is even higher than that of Brazil, and Argentina has also become a strong competitor for the U.S. in the world soybean market.

**Leading Global Soybean Consumers**

Leading global soybean consuming countries (or economic groups) include the U.S., China, Brazil, Argentina, and the EU-25. Figure 5 compares soybean consumption among these leading soybean consuming countries (USDA-FAS, 2006b). The U.S. is the number one soybean consumer in the world. In 2005, U.S. soybean consumption reached 51 million metric tons, accounting for 61% of U.S. soybean output. Brazil, ranking second in soybean consumption, consumed 31 million metric tons in 2005, accounting for 57% of its production. Argentina’s soybean consumption reached 31 million metric tons in 2005, accounting for 76% of its production. In contrast, China’s soybean consumption was 45 million metric tons in 2005, while China’s soybean production was only 18 million metric tons, resulting in a 27 million metric tons shortage.

![Figure 5. Leading Global Soybean Consumers](image)

Source: USDA-FAS, 2006b.
Soybeans compose a significant part of the human diet, especially for Asian countries. Soybeans were originally cultivated in China and later spread across Asia. Traditional soybean products include fermented products such as Indonesian tempeh and Japanese miso, and nonfermented products such as tofu, sauce, curd, beverage, and powder. Soybeans can be processed into soyoil and soymeal. Soyoil is widely consumed around the world as food oil, especially in China, while soymeal is used for animal feed. Figure 6 illustrates the soybean usage distribution of the world and the leading soybean consuming countries in 2004. Globally, only 6% of soybeans were used directly for food, and 86% of soybeans were crushed into meal for feed and oil for food or industrial usage in 2004 (USDA-FAS, 2006b). Thus, China’s domestic consumption has a greater proportion of soybeans used as food, e.g., tofu, sauce, curd, beverage, and powder.

![Figure 6. Comparison of Soybean Usage Distribution](image_url)

Source: USDA-FAS, 2006b.
In the U.S., over 60% of soybeans were consumed domestically. Of this, 8% were waste or used as seed, and 92% were crushed into soyoil and soymeal in 2005, whereas 83% of soymeal was manufactured into feed and 17% of soymeal was exported. For soyoil, 92% of it was used for food and only 8% exported (USDA-FAS, 2006b). Brazil, Argentina, and the EU followed a similar pattern to the United States. In contrast, China followed a different pattern for soybean consumption. In 2005, Chinese soybean consumption totaled 38 million metric tons, of which 21%, or 8 million metric tons, was used directly for food, and 74%, or 28 million metric tons, were crushed into soyoil for food and soymeal for feed (USDA-FAS, 2006b).

**Leading Global Soybean Exporters**

The top three soybean exporters in the world include the U.S., Brazil, and Argentina. Figure 7 shows that Brazil’s soybean exports reached 25 million metric tons in 2005, surpassing the U.S., and Brazil became the number one soybean exporter in the world. The U.S. exported 24 million metric tons of soybeans, a 3 million metric tons fall compared to 2004. Brazil’s soybean exports increased dramatically in the last decade from 4 million metric tons in 1995 to 25 million metric tons in 2005, an over 500% increase. Soybean exports from Argentina also increased in recent years, and reached 10 million metric tons in 2005. Brazil and Argentina became strong competitors for the U.S. in the world soybean market.
Figure 7. Leading Global Soybean Exporters

Source: USDA-FAS, 2006b.

Figure 8. Export Shares of Top Soybean Exporters in the World Soybean Market

Source: USDA-FAS, 2006b.
The export shares in the world soybean market for Brazil, the U.S., and Argentina were 39%, 37%, and 16%, respectively (USDA-FAS, 2006b) in 2005. The sum of soybean exports from these three countries accounted for 92% of the global total. The trends for market shares and the structural changes in the world soybean market are shown in figure 8. The U.S. soybean export share in the world market has been decreasing, especially in the last decade. In 1995, the U.S. soybean export share was 73%, but fell to 37% in 2005, a 36% market share loss in the world soybean market. In contrast, Brazilian market share in the world soybean market increased from 11% in 1995 to 39% in 2005, gaining 28% more within 10 years. Argentina also competes with the U.S. in the world soybean market, and Argentinean market share increased from 6% in 1995 to 16% in 2005.

**Leading Global Soybean Importers**

The leading global soybean importers include China, the EU-25, Japan, and Mexico as shown in figure 4. China’s soybean imports skyrocketed in the last decade from 0.8 million metric tons in 1994 to 27 million metric tons in 2005, an almost 27-fold increase, while soybean imports into the EU, Japan, and Mexico remained quite stable. In 2005, China’s soybean imports accounted for 41% of the world total (USDA-FAS, 2006b). Recall that China produced 18 million metric tons and its acreage annual growth rate was 3%. Thus soybean imports play an important role for Chinese consumers. The EU-25 imported 14 million metric tons of soybeans in 2005, which was 22% of global soybean imports. Soybean imports for Japan and Mexico were 4 million metric tons each. Japanese and Mexican soybean import shares were each only about 6% of the world total.
Summary

In summary, the leading global soybean producers are the U.S., Brazil, Argentina, and China. The leading global soybean consumers are the U.S., Brazil, China, Argentina, and the EU-25. The leading global soybean exporters include the U.S., Brazil, and Argentina, and the leading global soybean importers are China, the EU-25, Japan, and Mexico, as shown in Figure 10.

Figure 9. Leading Global Soybean Importers

Source: USDA-FAS, 2006b.
The growth of soybean production in the U.S. and China was quite steady, with an annual growth rate of 5% and 3%, respectively, in the last four decades. In contrast, the annual growth rate of the soybean industries in Brazil and Argentina were 15% and 28%, respectively, during the same period. However, soybean consumption in the U.S., Brazil, and Argentina did not increase as much as their production. Therefore, soybean exports became an important channel for the U.S., Brazil, and Argentina to deal with their soybean surplus. Soybean exports from Brazil and Argentina increased rapidly in recent years and became main competitors in the world soybean market.

On the other hand, the main global soybean importers, including the EU, Japan, and Mexico did not increase their soybean imports much in the past. In contrast, for China, as the number soybean importer, Chinese soybean imports skyrocketed in the last
decade and became the primary soybean import market in the world, attracting more attention from top soybean exporters, including the U.S., Brazil, and Argentina.
SOYBEAN POLICY REVIEW

Soybean Policies in the United States

U.S. Soybean Policies

Globally, the U.S. is the number one soybean producer, consumer, and exporter. Nationally, U.S. soybean production value reached $24 billion in 2004, ranking second among all agricultural bulk commodities behind corn (USDA-NASS, 2005). Compared with two other main commodities, corn and wheat, the planted area for soybeans has continuously increased in the United States, whereas the planted areas for corn and wheat have been either relatively stable or declined (Figure 11). From these trends shown in Figure 11, it is reasonable to expect that soybeans will surpass corn and become the number one (from a planted area perspective) agricultural bulk commodity in the United States, assuming that the U.S. does not make significant changes in current agricultural policies.

Behind the leading position for the U.S. soybean industry both nationally and internationally, the support policies for soybeans from the U.S. government played a very important role. The U.S. soybean subsidy program, instituted in 1941, was a commodity loan program, which supported soybean market prices. Under this program, producers used their soybeans as collateral for government loans. Depending on the market price level, farmers chose to either default on these non-recourse loans, keeping their loan and forfeiting soybean ownership to the U.S. Department of Agriculture (USDA), or farmers
could sell their soybeans and repay their loans plus interest (Westcott and Price, 1999, 2001).

Figure 11. Comparison of Planted Acres for U.S. Soybeans, Corn, and Wheat


The marketing loan program began in the mid-1980s and supported farmers’ incomes. Under this program, farmers could operate as described above. Alternatively, marketing loan provisions also allowed repayment of soybean loans at less than the original loan rate when soybean market prices fell (USDA-FSA, 2005a). Instead, government incentives encouraged farmers to retain ownership and sell their soybeans on the market at a price lower than the loan rate, rather than default on their loans and forfeit ownership to the USDA (Westcott and Price, 1999, 2001).

Under these government programs, U.S. government payments to soybean farmers increased rapidly, especially in the past decade. For example, net government expenditures totaled only $5 million in 1990 and increased to over $3 billion in 2001 as
shown in Figure 12 (USDA-FSA, 2005b). Because both domestic and international soybean prices recovered from very low to a higher level, the net government expenditures for soybeans dropped significantly in 2003 and 2004.

Figure 12. U.S. Net Expenditures on the Soybean Industry  
Source: USDA-FSA, 2005b.

Recent U.S. soybean policies include both direct government and counter-cyclical payments (CCP), both of which began with the 2002 Farm Bill and extend through 2007. A description of the calculation of each follows. The formula for direct government payments for soybeans is

(1) \[ \text{Direct payments} = \text{Base acreage} \times \text{Program yield} \times 85\% \times \text{Direct payment rate} \]

In regards to variable definitions, the USDA, Farm Service Agency (USDA-FSA) defines base acreage from farmers’ one time choice of the following options. This choice extends through 2007:
• “to use 2002 Production Flexibility Contract (PFC) acreage to establish CCP base acres;

• to use 2002 PFC acreage and add oilseed base history for the 1998-2001 crop years (three options were available under this scenario that allowed flexibility between oilseed base acres and other crop base acres); and

• to calculate all base acres using the farm’s planted and approved prevented planted history from 1998-2001” (USDA-FSA, 2003).

The program yield for the above direct government payments is obtained by multiplying the 1998 through 2001 average yield for soybeans times the historic yield ratio, which is the ratio that results from dividing the national average yield for soybeans, 1981-1985; by the national average yield, 1998-2001. The direct payment rate (DPR), set by the USDA, equals $0.44/bushel of soybeans in the 2002 Farm Bill. Direct payments relate only to planted acreage, regardless of the crop planted.

In contrast, the formula for counter-cyclical payments is more complicated than that for direct government payments. Counter-cyclical payments are influenced not only by base acreage and program yield, but also by soybean market prices (also referred to as marketing year average (MYA) price in the following formula). The formula for counter-cyclical payments (CCP) can be expressed as follows:

(2) Counter-cyclical payment = Base acreage × 85% × Program yield × CCP rate
(3) CCP rate = Max {0, (Target price – Effective price)}
(4) Effective price = Max {MYA price, Loan rate} + Direct payment rate (DPR)

The base acreage in equation (2) is defined above. For program yield in equation (2), farmers can use one of the following two methods:
• “93.5 percent of the 1998-2001 average yield; or
• the direct payment yield (PFC yield) plus 70 percent of the difference between the 1998-2001 average and the direct payment yield” (USDA-FSA, 2003).

The *counter-cyclical payment rate* (CCP rate) in equation (2) is related to both the *target price* and the *effective price*, determined in equation (3). The *target price* is set by the USDA. The *effective price* is affected by the *market year average (MYA price)*, the *loan rate* (see Figure 13), and the *direct payment rate* in equation (4).

![Figure 13. U.S. Loan Rate for Soybeans](source)

*Source: USDA-FSA, 2005a.*

*Counter-cyclical payments* are closely related to soybean market prices (*MYA prices*) through these three equations (2, 3, and 4). If soybean market prices (*MYA prices*) are higher than the national loan rate, then the *effective price* in equation (4) is the *MYA price* plus the *direct payment rate* ($0.44/bushel). If not, the *effective price* equals the *loan rate* plus the *direct payment rate* (DPR) in equation (4). For the *target price* in equation (3), the 2002 Farm Bill sets it at $5.80/bushel through 2007. When the *target*
price is higher than the effective price, the difference between the target price ($5.80/bushel) and the effective price is the CCP rate in equations (2) and (3). Otherwise the CCP rate is zero, i.e., if the target price is less than the effective price. Final countercyclical payments equal 85% of the base acreage multiplied by the program yield and the CCP rate, determined in equation (3). If the market price (MYA price) exceeds the loan rate in equation (4), so that the sum of the MYA price and the DPR, i.e., the effective price, is greater than the target price in equation (3), the CCP rate equals zero and countercyclical payments will not occur.

With these supportive policies, the U.S. soybean industry has developed steadily. Figure 14 shows U.S. soybean production, consumption, exports, and stocks. U.S. soybeans stocks have been quite stable in the past, and U.S. soybean production, consumption, and exports have been increased steadily.

![Figure 14. U.S. Soybean Production, Consumption, Exports, and Stocks](source: USDA-FAS, PS&D, 2006b).
**U.S. Biotech Policies**

The U.S. leads the world in agricultural biotechnology research, adoption, commercialization, and exports of biotech products. The main U.S. biotech varieties include soybeans, cotton, and corn. With the expectation of lower production costs, higher yields, and reduced herbicide use, U.S. farmers adopted biotech commodities immediately after they were available in 1996 (USDA-ERS, 2004). From 1996 to 2004, U.S. biotech commodities expanded dramatically. For example, in 2005, 87% of soybeans, 79% of cotton, and 52% of corn planted in the United States were biotech varieties as shown in Table 1 (USDA-ERS, 2005a).

**Table 1. Main U.S. Biotech Varieties (Percent of Planted Acreage)**

<table>
<thead>
<tr>
<th>Commodity</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybeans</td>
<td>54%</td>
<td>68%</td>
<td>75%</td>
<td>81%</td>
<td>85%</td>
<td>87%</td>
</tr>
<tr>
<td>Cotton</td>
<td>61%</td>
<td>69%</td>
<td>71%</td>
<td>73%</td>
<td>76%</td>
<td>79%</td>
</tr>
<tr>
<td>Corn</td>
<td>25%</td>
<td>26%</td>
<td>34%</td>
<td>40%</td>
<td>45%</td>
<td>52%</td>
</tr>
</tbody>
</table>


In the U.S., the U.S. Department of Agriculture, the Environmental Protection Agency (EPA), and the Food and Drug Administration (FDA) are jointly responsible for the regulation of biotech food commodities. Each of these three agencies has a different focus regarding the regulation of biotech food commodities: the USDA is primarily responsible for determining whether a new product is safe to grow or not; the EPA is in charge of the reviews of the potential impact on the environment imposed by any biotech commodities; and the FDA is focused on protecting consumers and has final authority to declare whether a product is safe to eat or not (UF-FEI, 2005).
Before the commercialization of any biotech commodities, field testing is required as a mandated part of the approval process. In 2001, there were about 13,000 multiple site field tests in the United States. In 1993, the FDA announced that biotech foods did not require any special regulation, as they were “not inherently dangerous”. Since the FDA approved the first biotech commodity -- the Flavr savr tomato -- in 1994, the USDA has approved more than 50 biotech commodities for planting, including corn, tomatoes, soybeans, cotton, potatoes, rapeseed (canola), squash, beets, papaya, rice, flax, and chicory (UF-FEI, 2005).

Currently the EU, China and Japan, require that any food products containing biotech contents should be labeled (Marchant, Fang, and Song, 2002). However, the U.S. does not require mandatory labeling for all biotech food products. At the 1997 Codex food labeling meeting, the U.S. delegate expressed U.S. stance on biotech products as

"Because foods derived from plants developed through different methods of breeding do not differ in any uniform manner; under United States laws and policies, the failure to identify a plant breeding process is not itself considered to be an omission of a material fact of the type that would cause the food to be misbranded. Thus, the United States believes that, as a class, foods obtained through biotechnology do not warrant any mandatory labeling with regard to the method by which they were obtained."

"The United States believes that, if consumers wish to have access to information on foods obtained through biotechnology, manufacturers ought to provide such information on a voluntary basis" (OCA, 2005).

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3.1 The Codex Alimentarius Commission is a United Nations body responsible for implementation of the Food and Agriculture Organization/World Health Organization Joint food Standards Program. This program was established to develop international food standards in the interests of enhancing consumer protection and ensuring fair international trade in food products. Codex Alimentarius is a Latin term meaning a code of law governing foods.
Brazilian Soybean Policies

Brazilian Agricultural Policies

Brazil has the largest economy in South America and the eighth-largest economy in the world, with a GDP of $635 billion in real terms (2000=100) in 2004 (USDA-ERS, 2006). Brazil is endowed with vast agricultural resources. Brazil’s agricultural area mainly includes two regions—the temperate south and tropical center-west. In the south, with temperate climate, higher rainfall, better soils, greater technology and input use, adequate infrastructure, and more experienced farmers, make Brazilian south its main grain, oilseed, and export commodities production area (Flaskerud, 2003).

Brazilian agriculture is well diversified, and the country is largely self-sufficient in food. Agriculture accounts for 8% of the country's GDP, and employs about one-quarter of the labor force in more than 6 million agricultural businesses. Brazil is the world's largest producer of sugarcane and coffee, and a net exporter of cocoa, soybeans, orange juice, tobacco, forest products, and other tropical fruits and nuts. Besides crop production, Brazilian livestock production is also very important in many sections of the country. On a value basis, production is 60% field crops and 40% livestock (Wikimedia Foundation, 2005).

Rapid urbanization and income growth caused great demand for both cooking oil and meat products. To meet domestic demand for meat products, the poultry, pork, and dairy industries developed quickly (Williams and Thompson, 1984). As a result, feed demand increased dramatically as well. Along with the increased demand for cooking oil, the demand for soybeans skyrocketed. This increased domestic demand along with
higher world soybean prices in the late 1990s, as well as government support policies, encouraged rapid expansion of soybean production in Brazil.

Prior to the 1990s, Brazil experienced an unstable macroeconomic environment, including hyperinflation, a heavy external debt burden, high interest rates, and periods of severe currency overvaluation. Brazil also imposed an import tax on agricultural inputs and export tax on agricultural products. These policies distorted domestic agricultural production (Peng, 2002; Schnepf, et al., 2001; Victor, Marchant, and Isinika, 1995).

In general, Brazil’s agriculture suffered much due to its unstable macroeconomic environment and unfavorable agricultural policies. However, Brazil’s soybean industry was a special case, which has been expanding. The reasons can be summarized as follows:

1. The Brazilian government considered soybeans as a strategic product for the government from both the standpoint of technological advancement and the volume of financial resources perspective. From the 1960s to the 1980s, the soybean industry contributed greatly to Brazil’s economy, at least from the following perspectives: “(1) saving foreign exchange, (2) increasing foreign exchange earnings, (3) improving the national diet, (4) stimulating industrial development, (5) holding down food price increases, and (6) territorial occupation.” (Warnken, 1999).

2. The Brazilian soybean industry benefited from its import-substitution strategy. After World War II, the Brazilian Government implemented an import-substitution strategy to stimulate the domestic economy and to reduce external debts. Under the import-substitution strategy, the agricultural sector lost their incentive to export and put
more pressure on Brazil’s limited foreign exchange reserves. To compensate for the shortage of foreign exchange, Brazil’s government gave the soybean industry special treatment to expand exports and increase foreign exchange (Schnepf, et al., 2001).

3. The government support policy played a key role in the Brazilian soybean boom. The Brazilian government’s supportive programs included the government acquisition program and the National Rural Credit System (Warnken, 1999). Under the government acquisition program, the Brazilian government set a minimum price level for soybeans and, if the market price was below the minimum price, the government would purchase soybeans from farmers at the minimum price. This program first began in 1975, and did not play an important role in the 1970s and early 1980s. In the late 1980s this program did protect Brazilian soybean farmers from low domestic soybean prices.

Brazil’s National Rural Credit System (NRCS) included three components: production credit, investment credit, and marketing loan credit (Warnken, 1999). Among these three components, production credit was the largest one. The government provided soybean farmers credit for their production of soybeans with “negative interest rates” (the inflation rate was higher than the loan interest rate) for most of the years from 1970 to 1990. In the late 1970s and the early 1980s, about 50% of Brazilian soybean production used government loans and production credits averaged about one-third of the total value of soybean output.

In contrast, investment credit provided farmers and cooperatives funds for their investments on infrastructure improvements, such as correction of soil acidity, soil conservation, rural electrification, and purchase of agricultural machinery, irrigation
equipment, and transportation vehicles (Warnken, 1999). Investment credit was also subsidized by a “negative interest rate” similar to production credit. The marketing loan program primarily helped soybean cooperatives and processors for soybean storage and transportation, as well as processing. The government provided loans to cooperatives or processors for up to six months with a “negative interest rate”.

Since the mid-1990s, the Brazilian government changed its agricultural policies and tried to eliminate its minimum price intervention and government buffer stock gradually (USDA-ERS, 2002). At the same time, the Brazilian government used Federal taxes in addition to an array of state taxes on agricultural exports. Currently, although Brazilian subsidy programs still exist, they do not play as important a role as they did before.

With all of these support programs, Brazil has been a net exporter of soybeans (see Figure 15), and a strong competitor for the U.S. in the international soybean market. In 2005, soybean production in Brazil totaled 57 million metric tons, accounting for 25% of the world total (USDA-FAS, 2006b). However, Brazilian domestic demand for soybeans did not increase as fast as production. Therefore, the Brazilian government used soybean exports to reduce its domestic soybean surplus. In 2005, Brazilian soybean exports reached 22 million metric tons, an increase of 18 million metric tons, compared with 4 million metric tons of soybean exports in 1994, and became the second largest soybean exporter in the world soybean market, competing with the U.S. and Argentina. One interesting observation is that Brazilian soybean stock changes. Prior to 1999, Brazilian soybeans stocks were very low. However, after 1999, Brazilian soybean stocks increased dramatically from less than 1 million metric tons in 1999 to 17 million metric
tons in 2005. This huge soybean stock increase implies that Brazilian soybean storage capacity has been improved greatly. In addition, this improved infrastructure may increase Brazil’s competitiveness in the international market. From another perspective, Brazil also needs to boost their soybean exports to avoid continuous increase of their soybean stockpile.

![Graph showing Brazilian soybean production, consumption, exports, and stocks from 1965 to 2005.](source)

**Figure 15. Brazilian Soybean Production, Consumption, Exports, and Stocks**

Source: USDA-FAS, PS&D, 2006b.

**Brazilian Biotech Policies**

For biotech policies in Brazil, the Brazilian Government invested heavily in biotech research and development in the early 2000s with estimated $15 million per year since 2001 (James, 2004). However, adoption and commercialization of biotech commodities were not allowed before 2003. Although the Government banned biotech agricultural production in Brazil, illegal growing of biotech commodities, mainly biotech soybeans, was quite common in Brazil before 2003. Finally, the Brazilian Government
officially approved planting of biotech soybeans in 2003. The approval was temporary, pending the passage of a biotech bill that will provide a permanent framework for evaluating and approving biotech commodities in Brazil (James, 2005). In 2005, Brazil experienced the largest increase in biotech soybean adoption relative to total production of soybeans, with 9.4 million hectares of biotech varieties compared with 5 million in 2004.

**Argentinean Soybean Policies**

*Argentinean Agricultural Policies*

Argentina is the second largest country in South America and the eighth largest in the world. Argentina has a wealth of natural resources and a good climate, which gives Argentina a natural advantage in agricultural production. From the early 1950s, Argentina was already a major corn and wheat producer but did not produce much soybeans. Similar to Brazil, Argentinean agriculture suffered due to high inflation, an often overvalued exchange rate, and a heavy external debt burden.

Although the Argentinean Government undertook a series of programs to stabilize its macroeconomic conditions during the 1960s, 1970s, and 1980s, their macroeconomic environment had not improved (Peng, 2002; Schnepf, et al. 2001). In addition, the Argentinean Government adopted an import substitution strategy, which further dampened their agricultural industry. Under this import substitution strategy, the Argentinean Government tried to control and reduce imports by setting high tariffs and quantitative restrictions (quotas), export taxes, and manipulated exchange rates. Prior to 1977, Argentinean import tariffs on fertilizers and agricultural chemicals were 60 and 65
percent. Export taxes on grains and oilseeds were initially set at 18 percent in 1982, and varied each year. As a result, Argentinean farmers had to use their inefficient, overpriced domestic inputs, and sold their agricultural products domestically at lower prices.

In 1991, Argentina enacted economic reforms moving toward a free market economy. Schnepf, et al. (2001) summarized the main reform policies related to agriculture in Argentina as follows:

- “The elimination of all export taxes on major grain and processed oilseed products in 1991, except for the 3.5-percent tax on unprocessed oilseed exports.
- The elimination of all quantitative restrictions on imported agricultural inputs.
- The reduction of tariffs on imported agricultural inputs to a range not to exceed 15 percent of CIF (cost, insurance, and freight) value, although an additional 10-percent tax was levied on most imported agricultural inputs.
- The exemption from tariffs and taxes of agricultural inputs classified as capital goods—i.e., those whose economic life extends beyond one production cycle—such as embryos, certified seed, and trucks.
- The elimination of several government commodity agencies that held export monopolies for their respective commodities (e.g., the National Grain Board, the National Meat Board, and similar agencies for sugar and tobacco).
- The initiation of privatization in the marketing and transportation infrastructure, including state-owned grain elevators, port facilities, and railroads.”

These favorable policies along with high international prices for soybeans greatly spurred Argentinean soybean production. In 2005, soybean output in Argentina reached 41 million metric tons, accounting for 18% of world soybean production, ranking third globally behind the U.S. at 38% and Brazil at 25% (USDA-FAS, 2006b). However, soybean consumption in Argentina did not grow as quickly as soybean production (Figure...
The Argentinean population is small and stable and the livestock industry is also relatively small. In addition, the cattle industry in Argentina is predominantly grass-fed; thus soymeal demand is limited. As a result, the international market was Argentina’s primary choice to deal with its soybean surplus. Argentinean soybean exports increased dramatically from 2.6 million metric tons in 1994 to 10 million metric tons in 2005, which accounted for 16% of world soybean exports (USDA-FAS, 2006b).

Figure 16. Argentinean Soybean Production, Consumption, Exports, and Stocks
Source: USDA-FAS, 2006b.

Argentinean Biotech Policies

For Argentina’s biotech policies, Argentina conducted field trials for biotech soybeans as early as 1986, and began to grow biotech soybeans commercially in 1996. Following its introduction, biotech soybeans expanded dramatically in Argentina. In 2005, almost the entire national planted area for soybeans was biotech varieties, leading the world in biotech soybean adoption and commercialization (James, 2005).
With abundant arable land and quick adoption of new technology, Argentina is a strong competitor in the international soybean market. However, one disadvantage for the Argentinean soybean industry is that is Argentina’s pervasive policy intervention that ultimately promoted other sectors of the economy at the expense of agriculture. For example, although its export tax was eliminated in 1991, in March 2002 a 13.5 percent export tax was imposed on soybeans and a 10 percent tax on most other primary agricultural products (Torgerson, 2002). Then in April 2002, export taxes were raised to 20 percent for many agricultural products, including soybeans, wheat, feed grains, and vegetable oils and soymeal. Soybeans were still assessed a 3.5 percent surcharge, making the export tax 23.5 percent for soybeans. This recently re-imposed export tax dampened the soybean industry in Argentina and weakened their advantage in the international soybean market.

**Chinese Biotech Policies and Soybean Trade**

*China’s Situation and Outlook*

With a population of 1.3 billion and an annual GDP growth rate of more than 8% in the past decade, China is not only a large producer of agricultural commodities, but also a large consumer of agricultural commodities including soybeans. In 2004, China produced 31% of world rice, 27% of rapeseed, 19% of corn, 27% of cotton, 16% of wheat, and 9% of soybeans (FAO, 2005). China is also a large player in international grain and oilseed markets, exporting almost four million metric tons of corn and importing 27 million metric tons of soybeans in 2005 (USDA-FAS, 2006b).
In the past, China was also a major soybean exporter in the world market. However, recently, demand for soybeans in China increased dramatically resulting in China becoming a net importer in the late 1990s from a net exporter in the 1980s. Figures 17 and 18 show the change of China’s status in the soybean world market (USDA-FAS, 2006b). The main soybean suppliers for China include the U.S., Brazil, and Argentina. Since 85% of U.S. soybeans, 22% of Brazilian soybeans, and 98% of Argentinean soybeans were biotech varieties in 2004, any changes in China’s biotech policies may have a significant impact on China’s soybean trade.

Figure 17. Chinese Soybean Production, Consumption, Imports, and Exports

Source: USDA-FAS, 2006b.
Chinese Biotech Policies and Trade Impacts

Since 1986, China has invested heavily in biotech research, ranking second only to the United States (Huang and Wang, 2002). By the year 2001, more than 130 species were obtained, including insect-resistant, bacterial-, fungus- and virus-resistant, salt-tolerant, drought-resistant, nutrition enrichment, quality improvement, production of edible oral vaccines and recombinant pharmaceuticals (Marchant and Song, 2005). However, only Bt cotton, delayed ripening tomatoes, cucumber mosaic virus (CMV)-resistant sweet peppers, and color-altered petunias were approved for production within China. By far, Bt cotton is the dominant biotech commodity in China, and no other food commodities have been approved for production (Marchant, Fang, and Song, 2002).
Currently, the Chinese government is struggling with the adoption and commercialization of biotech rice. China’s agricultural researchers state that biotechnologies for rice are mature and ready for adoption and commercialization. An official from the Chinese MOA said that they have already accepted the application for the safety evaluation (for the safety certificate) of biotech rice varieties (Cheng and Peng, 2002). This official also mentioned that accepting the safety evaluation does not mean that the government will approve the adoption and commercialization of biotech rice varieties. Before commercialization of biotech rice, a series of field experiments, production experiments and other related experiments are required. The Chinese government will be very cautious in the adoption and commercialization of biotech rice, since currently no other countries have approved biotech rice for large-scale commercialization (Song and Marchant, 2005).

Field tests, environmental releases and commercialization of biotech plants are regulated in China (Figure 19). In November, 1993, the State Science and Technology Commission of China (SSTC) issued “Biosafety Administration Regulations on Genetic Engineering”, which was the first law on biosafety in China (Marchant, Fang, and Song, 2002). Three years later, “Biosafety Administration Implementation Regulations on Agricultural Genetic Engineering” was issued by the Chinese Ministry of Agriculture (MOA), and took effect on the same date, July 10, 1996 (Chinese MOA, 1996).
“Biosafety Administration Regulations on Genetic Engineering” was issued by the State Science and Technology Commission and took effect on the same date, **December 24, 1993**.

“Biosafety Administration Implementation Regulations on Agricultural Genetic Engineering” was issued by the Ministry of Agriculture of China, and took effect on the same date, **July 10, 1996**.

“Biosafety Administration Regulations on Agricultural Transgenic Products” were passed by the State Council of China on **May 9, 2001**, and issued and took effect on **May 23, 2001**.

(1)“Biosafety Evaluation and Administration Regulations on Agricultural Transgenic Products,” (2)“Labeling Administration Regulations on Agricultural Transgenic Products,” and (3)“Import Safety Administration Regulations on Agricultural Transgenic Products” were passed by the Chinese Ministry of Agriculture on July 11, 2001, with an effective date for implementation on **March 20, 2002**.

“Temporary Administration Procedure of Import of Agricultural biotech Products” was issued on March 10, 2002 before the above effective date March 20, 2002, and was scheduled to terminate on **December 20, 2002**.

On April 8, 2002, the Chinese Ministry of Health issued “the Sanitary Administration Rules for Transgenic Food” which took effect on **July 1, 2002**.

On October 11, 2002, the Chinese Ministry of Agriculture announced that the above temporary import regulations would be extended to **September 20, 2003**.

On July 17, 2003, the Chinese Ministry of Agriculture announced that the above temporary import regulations would be further extended to **April 20, 2004**.

The temporary import regulations expired and the above three regulations took effect on **April 20, 2004**.

“**The Administrative Measures of Inspection and Quarantine on Entry-Exit Transgenic Products**” was issued on May 24, 2004 by China's State General Administration for Quality Supervision, Inspection and Quarantine (AQSIQ) and took effect on the same day.

Figure 19. History of China’s Biotech Regulations
Prior to China’s accession into the World Trade Organization on December 11, 2001, the Chinese government passed its “Biosafety Administration Regulations on Agricultural Biotech Products,” which were issued and took effect on May 23, 2001 (Chinese MOA, 2001a). These regulations provided general guidelines for the development, distribution, and use of agricultural biotech products and required a safety certificate and labeling for any agricultural biotech products from either domestic sources or imports. The Chinese MOA issued three separate implementing regulations for the above guidelines on January 5, 2002: (1) “Biosafety Evaluation and Administration Regulations on Agricultural Biotech Products,” (2) “Import Safety Administration Regulations on Agricultural Biotech Products,” and (3) “Labeling Administration Regulations on Agricultural Biotech Products” (Chinese MOA, 2001b). These new regulations placed restrictions on Chinese imports of biotech products, including those imported from the United States. The effective date for implementation was originally set for March 20, 2002.

Specific rules on imports of biotech products from the above regulations included the following:

(1) biotech products imported into China required test results or data obtained from in-country field experiments within the exporting country (or a third country) to prove that the products are safe for human consumption and do not impose biosafety risks to other plants, animals, or the environment,

(2) each shipment of biotech products imported into China needs a single or separate safety certificate accompanying each shipment,
(3) the Chinese Ministry of Agriculture’s approval process can take up to 270 days to grant safety certificates required for imported biotech products,

(4) there is a "zero" threshold level (based on qualitative test results) for biotech content in foods,

(5) decision-making should be based on demonstrated risks (biohazards) from scientific data, whereby the expert panel should play an important role in the decision-making process.

Rules on labeling biotech products included the following:

(1) all products containing biotech content should be labeled correctly, otherwise, the products are not allowed to enter unless they are re-labeled,

(2) labeling rules are applied to the following imported biotech products: soybean seeds, soybeans, soybean flour, soymeal, soyoil, corn seeds, corn, corn oil, corn meal, rapeseed seeds, rapeseeds, rapeseed oil, rapeseed meal, cotton seeds, tomato seeds, fresh tomatoes, and tomato ketchup (tomato jam).

Before the effective date to implement these three regulations (March 20, 2002), the Chinese government delayed their implementation (Chinese MOA, 2003). Instead, the Chinese MOA issued a temporary measure, “Temporary Administration Procedure of Import of Agricultural Biotech Products”, which allowed exporters to ship biotech products, including U.S. biotech soybeans, into China using temporary import certificates through December 20, 2002. Each temporary import certificate granted by the Chinese MOA was good for 10 shipments (Chinese MOA, 2002). After three extensions of this temporary measure, the above three regulations eventually took effect on April 20, 2004 (USDA-FAS, 2004).
Immediately after the effective date of implementation for these three regulations, China's State General Administration for Quality Supervision, Inspection and Quarantine (AQSIQ) announced a new regulation related to the administration of biotech products, “Administrative Measures of Inspection and Quarantine on Entry-Exit of Biotech Products”, on May 24, 2004 (Chinese AQSIQ, 2004; USDA-FAS, 2004). These measures not only apply to the inspection and quarantine of biotech products via trade, but also apply to processing, research, and production. By these new measures, Chinese importers must declare whether the imported products are biotech or not when they apply for inspection and quarantine. If the products are biotech, the importers shall provide relevant documents including a safety certificate and review and approval documents needed for labeling. For biotech products, labeling is mandatory by the above implementing regulations. In addition, these measures also authorize the AQSIQ to conduct random biotech tests even if products are declared as non-biotech.

China’s biotech regulations and policies did raise concern by U.S. agricultural exporters and policymakers as well as Chinese agricultural importers. Requiring safety certificates incurred additional costs and shipment delays at the initiation of these new regulations in the late spring and summer of 2001. In addition, these regulations have the potential to be used by the Chinese government as a non-tariff barrier to control soybean imports. Upon examining monthly data, Song and Marchant (2005) found that China’s biotech policy did not impose significant impacts on U.S. soybean exports to China in the long-run. This conclusion will be empirically tested in this research.
The Lerner Index

Lerner (1934) developed an index (the Lerner Index) to measure market power of a single firm. The Lerner index is defined as

\[ LI = \frac{P - MC}{P} \]

where the variable \( P \) is the market price and \( MC \) is the marginal cost. The Lerner Index is able to measure the degree of market power of a firm in an imperfect market, but it was difficult to use empirically because marginal cost data are typically unavailable. However, the Lerner Index does provide a provocative idea to measure market power. Based on the Lerner Index, subsequent literature found other ways to approximate the Lerner Index to measure market power in an imperfectly competitive market. These measures include Pricing to Market Model and Residual Demand Elasticity Model.

Pricing to Market Model

Krugman (1986) first developed the concept of “pricing to market” (PTM). PTM was used to address the relationship between the changes in exchange rates and import prices. Krugman defined PTM as “import prices fall ‘too little’ when a currency appreciates.” Upon examining the trade data of U.S. imported manufactured products from Germany, Krugman summarized as “pricing to market when the exchange rate changes is a real phenomenon” and “PTM is not universal.” Krugman also suggested both static and dynamic models to explain PTM. His static and dynamic models included
supply and demand, monopolistic price discrimination, and oligopolistic models.

Krugman concluded in his paper, “explaining pricing to market is not as simple as one might hope. It seems clear that a perfectly competitive model will not do the trick…” and “the best hope of understanding pricing to market therefore seems to come from dynamic models of imperfect competition.”

Although Krugman did not attempt to find a better explanation for PTM, his provocative research did bring attention to subsequent researchers. At the end of the 1980s, the U.S. dollar depreciated sharply, and the relationship between U.S. exports and fluctuations of the exchange rates attracted researchers’ interests. Knetter (1989) developed a specific functional model to study PTM associated with exchange rate fluctuation. Based on solving an exporters’ profit maximizing problem, Knetter (1989) established his model

\[ \ln p_{it} = \theta_i + \lambda_i + \beta_i \ln s_{it} + u_{it} \]

where the variable \( p_{it} \) is the export price to destination market \( i \) at period \( t \), and \( s_{it} \) is the exchange rate (destination market’s currency per unit of exporter’s currency) of the destination market \( i \) at period \( t \). The parameter \( \beta_i \) measures the elasticity of the export price changes relative to the exchange rate changes. The parameter \( \theta_i \) is the time effect, \( \lambda_i \) the country effect, and \( u_{it} \) the regression disturbance. Knetter’s model was able to distinguish between three different market conditions: a competitive market, an integrated market, and a noncompetitive market, depending on the estimated coefficients values for \( \lambda_i \) and \( \beta_i \).
If the market is competitive, by the Lerner Index we know that price equals marginal cost and the Lerner Index is zero. In this case, the time effect, $\theta_i$, measures the common price and there is no variation in the data correlated to the country effect, $\lambda_i$, or the exchange rate, $s_a$. In this model, the estimated coefficients for $\lambda_i$ and $\beta_i$ should be zero.

In contrast, if one or both of the estimated coefficients of $\lambda_i$ and $\beta_i$ are not zero, then the market is not competitive. Knetter applied this model to U.S. exports of onions, bourbon, orange juice, breakfast cereal, refrigerators, and switches, as well as German exports of fan belts, titanium dioxide pigment, small cars, large cars, beer, white wine, sparkling wine, and potassium chloride. Knetter’s estimation results indicated that “U.S. export prices are rather insensitive to exchange rate fluctuations,” and “German export prices appear to be much more sensitive to exchange rate fluctuations.”

Using a similar model, Knetter (1993) subsequently studied the PTM behaviors from both source and destination countries in the world market. Knetter used industry level data from the U.S., the United Kingdom, Germany, and Japan to compare the PTM behaviors from these countries. Knetter found that the PTM behaviors were very similar across source countries, including Germany, Japan, and the United Kingdom. For U.S. exports, the PTM behaviors were very similar across destination markets.

The PTM model basically deals with the relationship between export prices and exchange rates. However, the PTM model does not work in China’s case, since the Chinese exchange rate does not fluctuate but rather is pegged to the U.S. dollar. The exchange rates between Chinese currency, RMB (Yuan), and U.S. dollars were quite
stable for a long time. Figure 20 shows that the exchange rate between Chinese currency, RMB (Yuan), and the U.S. dollar was almost constant at 8.28 (RMB/USD) from 1998 to 2005 (USDA-ERS, 2006). Recently, under international pressure, the Chinese Government promised to reform China’s exchange rate policy, and is now practicing limited floating exchange rates. The current exchange rate is 8.01(RMB/USD) as of May 2006, showing slight movement.

![Graph of Exchange Rate between Chinese Yuan (RMB) and U.S. Dollars](image)

**Figure 20. Exchange Rate between Chinese Yuan (RMB) and U.S. Dollars**


**Residual Demand Elasticity Model**

Baker and Bresnahan (1988) first developed the residual demand model to measure market power of a single firm in an imperfect market. Baker and Bresnahan argued that under perfect competition with homogeneous products, if a firm reduced its production, then other firms would offset the shortage due to one firm’s contraction. Therefore the residual demand faced by any single firm was infinitely elastic. However,
with imperfect competition or differentiated products, the residual demand curve faced by a single firm was negatively sloped. They defined the inverse demand function for the firm of interest (firm 1) as

\[ P_1 = P_1(Q_1, Q, Y; \alpha^1) \]  \hspace{1cm} (7)  

where the variables \( P_1 \) and \( Q_1 \) are price and quantity for firm 1’s product, \( Q \) is a vector of quantities for substitute products produced by the other firms, \( Y \) is a vector of exogenous demand shifters, and \( \alpha^1 \) are parameters. If assuming that all products are homogenous, then equation (7) can be written as

\[ P_1 = P_1(Q_1 + \sum_i Q_i, Y; \alpha^1) \]  \hspace{1cm} (7')  

In regards to vector \( Q \) in equation (7), it is expressed in a similar inverse residual demand form

\[ P_1 = P_i(Q_i, Q_1, Y; \alpha^i) \]  \hspace{1cm} (8)  

for all \( i \neq 1 \).

The third component in Baker and Bresnahan’s model includes the supply behavior of all firms for \( i \neq 1 \). These supply relations are written through the marginal cost (MC) equaling the perceived marginal revenue (PMR)

\[ MC^i(Q_i, W, W^i; \beta^i) = PMR^i(Q_i, Q, Y; \alpha^i, \theta^i) \]  \hspace{1cm} (9)  

where the expression \( PMR^i(\cdot) \) is \( P^i(\cdot) + Q_i \cdot \sum_j [(\partial P^i / \partial Q_j)(\partial Q_j / \partial Q_i)] \). The vector \( W \) is the industry-wide factor prices and the vector \( W^i \) is the firm-specific factor prices.
Parameters $\beta^i$ are associated with the marginal cost function, and the parameter $\theta^i$ indexes the oligopoly solution component ($\partial Q_j / \partial Q_i$) for all firms.

Single firm’s residual demand function was derived by solving equation (8) and (9) simultaneously for the vectors $Q$ and $P$. In implicit form, the solution could be written as

$$Q = E^i(Q_i, Y, W, W^i; \alpha^i, \beta^i, \theta^i)$$

where the function $E^i(\cdot)$ means that this was the equilibrium quantity in all markets for $i \neq 1$. Finally, substituting equation (10) into equation (7) and removing redundancies, equation (7) becomes

$$P_i = R(Q_1, Y, W, W^1; \alpha, \beta^i, \theta^i)$$

where the function $R(\cdot)$ is the inverse residual demand function for firm 1.

Baker and Bresnahan took three U.S. brewing firms – Anheuser-Busch, Coors, and Pabst – as their samples to estimate and analyze the residual demand curves faced by these three companies. They found that for the period 1962-1982, Anheuser-Busch had some market power, Coors had substantial market power, and Pabst had no market power. Baker and Bresnahan’s work provided a new approach to measure market power of a single firm with differentiated products within a national market.

Goldberg and Knetter (1999) adopted the residual demand model to measure the degree of competition in segmented export markets. They started from the general case,
which assumed homogenous products and a group of exporters facing a particular foreign
destination market, and defined the residual demand function as

\[ P_{ex} = D_{ex} (Q_{ex}^{}, P^1, ..., P^n, Z) \]

\[ P^k = D^k (Q^k, P^j, P_{ex}^{}, Z) \text{ where } j = 1, ..., n \text{ and } j \neq k \]

where the variable \( P_{ex} \) is the price of the exported good, and \( Q_{ex} \) is the total export
quantity. The variables \( P^i, \ldots, P^n \) are the prices of \( n \) competing products produced in
other countries, and \( Z \) is a vector of demand shifters in the destination markets.

By solving the exporters’ profit maximizing problem, Goldberg and Knetter wrote
the specific functional form of the first order condition as

\[ \ln P_{ex}^m = \lambda_m + \eta_m \ln Q_{ex}^m + \alpha_m \ln Z_m + \beta_m \ln W^N_m + \varepsilon_m \]

where the subscript \( m \) indexes a specific market, the vector \( Z \) denotes demand shifters for
destination market \( m \), and the vector \( W \) consists of cost shifters for the \( N \) competitors
faced by the export group in a particular destination market. Finally, the random
disturbance \( \varepsilon \) is independently and identically distributed (i.i.d.).

Goldberg and Knetter used annual data for U.S. Kraft linerboard paper (1973-
1987) and German beer (1975-1993) to estimate this model. In the case of German beer,
their empirical results indicated that “the elasticity of the residual demand curve German
exporters face in each destination is closely related to the presence of the Netherlands as
a competitor,” and for U.S. linerboard exports, “strong evidence of imperfect competition
in the case of Australia, which is a very small market where U.S. firms face almost no competition from other producers."

Carter, et al. (1999) tested the world wheat market using the residual demand elasticity (RDE) model. Their application of RDE model to the world wheat market provided a new approach to measure market power for wheat, a key international bulk agricultural commodity market. Carter, et al. assumed that each country was a firm, and that parameters could be interpreted as share-weighted industry averages for all firms within one country. Based on Goldberg and Knetter’s RDE model, Carter, et al. directly defined the reduced form of the inverse residual demand function for U.S. wheat as

\[
\ln P_t^u = \alpha + \eta \ln Q_t^u + \beta^c \ln W_t^c + \beta^a \ln W_t^a + \gamma \ln Z_t + \epsilon_t
\]

where the variable \( P_t^u \) is the price of U.S. wheat exported to Japan in yen, and \( Q_t^u \) represents the quantity of U.S. wheat exported to Japan. The vector \( W_t^c \) is a set of cost shifters for a 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. Parameters \( \alpha, \eta, \beta, \) and \( \gamma \) are to be estimated. The error term \( \epsilon \) is assumed to be distributed independently and identically. The subscript \( t \) stands for time period.

Through this double-log form Carter, et al. estimated the price flexibility for U.S. wheat exports to Japan directly.

Carter, et al. used quarterly data (1970 to 1991) to estimate their model (15). Their 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.”
Glauben and Loy (2003) compared the PTM model and the RDE model when examining market power for German food and beverage export industries over international markets. They found controversial results from these two models: in some cases the PTM model indicated market power, while the RDE model did not. They explained this conflict by fixed contracts, which were often used in the food and beverage export market.

Poosiripinyo and Reed (2005) applied the RDE model to the Japanese chicken meat market and estimated price flexibilities of Japanese inverse residual demand for whole birds, legs with bone, and other cuts from Brazil, China, Thailand, and the United States. Their results indicated that only Brazil (in whole birds and leg with bone) and the U.S. (in other cuts) have significant market power over Japanese chicken meat importers as shown in Table 2 (Poosiripinyo and Reed, 2005).

**Table 2. Summary Results of Residual (Inverse) Demand Elasticities**

<table>
<thead>
<tr>
<th>Products</th>
<th>Brazil</th>
<th>China</th>
<th>Thailand</th>
<th>United States</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole Birds</td>
<td>-0.253**</td>
<td>-0.108</td>
<td>0.104**</td>
<td>-0.111</td>
</tr>
<tr>
<td>Legs with Bone</td>
<td>-0.103**</td>
<td>-0.048</td>
<td>-0.061</td>
<td>0.024</td>
</tr>
<tr>
<td>Other Cuts</td>
<td>-0.020</td>
<td>-0.020</td>
<td>-0.081</td>
<td>-0.229**</td>
</tr>
</tbody>
</table>

** significant at 1% level  
* significant at 5% level

Poosiripinyo (2004) summarized the advantage and disadvantages of the RDE model. The advantages of the RDE model include 1) the RDE model can measure
market power with modest data requirements, which are generally lacking in domestic and international markets; 2) the RDE model can be defined in double-log form and the elasticity can be estimated directly; and 3) the RDE model can incorporate exchange rate variable in the model as an indicator of marginal cost change. The disadvantages of the RDE model include 1) the RDE model entails a loss of price elasticity of demand; and 2) the estimated coefficients are difficult to interpret. With these disadvantages of the RDE model, however, in cases where the Lerner Index is very difficult or infeasible to compute, the RDE model appears to be the next best alternative to evaluate market power.

**Review of World Soybean Market Studies**

*The FAPRI/CARD International Oilseed Model*

The Food and Agricultural Policy Research Institute (FAPRI) in the Center for Agricultural and Rural Development (CARD) developed an International Oilseed Model, a non-spatial, partial-equilibrium econometric global model. The FAPRI’s international oilseed model includes major oilseed producing, exporting, and importing countries or regions. Their model also assumes each seed, meal, and oil as a homogeneous commodity. A key factor in the FAPRI’s model is that when world prices are linked to domestic prices, estimated or consensus price transmission elasticities are used, assuming that agents in each country are price-takers in the world market (FAPRI/CARD, 2005).

FAPRI/CARD’s price transformation model was written as

\[
P^D = \alpha + \beta P^w r (1 + d)
\]

(16)  \[ P^D = \alpha + \beta P^w * r * (1 + d) \]

Where \( P^D \) is the domestic price, and \( P^w \) is the world price of the commodity including
international transportation costs. Variable $r$ is the exchange rate, and $d$ captures policy interventions between the world and domestic markets and is expressed in *ad valorem* form. Parameter $\alpha$ and $\beta$ are to be estimated.

The FAPRI/CARD international oilseed trade model incorporated four oilseeds including soybeans, rapeseed, sunflower seed, and peanuts. Their model also included palm oil, palm kernel meal, and palm kernel oil. The countries/regions covered in their model can be found in Table 3 (FAPRI/CARD, 2005).

<table>
<thead>
<tr>
<th>Soybeans</th>
<th>Soybean Meal</th>
<th>Soybean Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>Argentina</td>
<td>Argentina</td>
</tr>
<tr>
<td>Brazil</td>
<td>Brazil</td>
<td>Brazil</td>
</tr>
<tr>
<td>Canada</td>
<td>Canada</td>
<td>Canada</td>
</tr>
<tr>
<td>China</td>
<td>China</td>
<td>China</td>
</tr>
<tr>
<td>EU New Member States</td>
<td>EU New Member States</td>
<td>EU New Member States</td>
</tr>
<tr>
<td>European Union - 15</td>
<td>European Union - 15</td>
<td>European Union - 15</td>
</tr>
<tr>
<td>India</td>
<td>India</td>
<td>India</td>
</tr>
<tr>
<td>Japan</td>
<td>Japan</td>
<td>Japan</td>
</tr>
<tr>
<td>Other Former Soviet Union</td>
<td>Other Former Soviet Union</td>
<td>Other Former Soviet Union</td>
</tr>
<tr>
<td>South Korea</td>
<td>South Korea</td>
<td>South Korea</td>
</tr>
<tr>
<td>Taiwan</td>
<td>Taiwan</td>
<td>Taiwan</td>
</tr>
<tr>
<td>United States</td>
<td>United States</td>
<td>United States</td>
</tr>
<tr>
<td>Rest of World</td>
<td>Rest of World</td>
<td>Rest of World</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rapeseed</th>
<th>Rapeseed Meal</th>
<th>Rapeseed Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>Canada</td>
<td>Australia</td>
</tr>
<tr>
<td>Canada</td>
<td>China</td>
<td>Canada</td>
</tr>
<tr>
<td>China</td>
<td>EU New Member States</td>
<td>China</td>
</tr>
<tr>
<td>EU New Member States</td>
<td>European Union - 15</td>
<td>EU New Member States</td>
</tr>
<tr>
<td>European Union - 15</td>
<td>India</td>
<td>European Union - 15</td>
</tr>
<tr>
<td>India</td>
<td>Japan</td>
<td>India</td>
</tr>
<tr>
<td>Sunflower Seed</td>
<td>Sunflower Meal</td>
<td>Sunflower Oil</td>
</tr>
<tr>
<td>-------------------------</td>
<td>-------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Argentina</td>
<td>Argentina</td>
<td>Argentina</td>
</tr>
<tr>
<td>China</td>
<td>China</td>
<td>China</td>
</tr>
<tr>
<td>EU New Member States</td>
<td>EU New Member States</td>
<td>EU New Member States</td>
</tr>
<tr>
<td>European Union - 15</td>
<td>European Union - 15</td>
<td>European Union - 15</td>
</tr>
<tr>
<td>Other Former Soviet Union</td>
<td>Other Former Soviet Union</td>
<td>Other Former Soviet Union</td>
</tr>
<tr>
<td>United States</td>
<td>United States</td>
<td>United States</td>
</tr>
<tr>
<td>Rest of World</td>
<td>Rest of World</td>
<td>Rest of World</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Palm Oil</th>
<th>Palm Kernel Meal</th>
<th>Palm Kernel Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>European Union - 15</td>
<td>China</td>
</tr>
<tr>
<td>European Union - 15</td>
<td>Indonesia</td>
<td>European Union - 15</td>
</tr>
<tr>
<td>India</td>
<td>Malaysia</td>
<td>Indonesia</td>
</tr>
<tr>
<td>Indonesia</td>
<td>Rest of World</td>
<td>Malaysia</td>
</tr>
<tr>
<td>Malaysia</td>
<td></td>
<td>Rest of World</td>
</tr>
<tr>
<td>Rest of World</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Peanuts</th>
<th>Peanut Meal</th>
<th>Peanut Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>Argentina</td>
<td>Argentina</td>
</tr>
<tr>
<td>Canada</td>
<td>China</td>
<td>China</td>
</tr>
<tr>
<td>China</td>
<td>European Union - 15</td>
<td>European Union - 15</td>
</tr>
<tr>
<td>European Union - 15</td>
<td>India</td>
<td>India</td>
</tr>
<tr>
<td>India</td>
<td>United States</td>
<td>United States</td>
</tr>
<tr>
<td>Mexico</td>
<td>Rest of World</td>
<td>Rest of World</td>
</tr>
<tr>
<td>United States</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rest of World</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From a supply perspective, the FAPRI/CARD’s international oilseeds model incorporates equations for area harvested, yield and production. From the demand side, it
includes crush, seed, food, stocks, and other consumption. “The crush demand is driven by the oil demand and/or by meal demand. Given the joint product of oil and meal and the positive economic value attached to meal, the derived demand from crushing reflects both oil and meal. The derived demand for crush oilseeds is driven by the crush margin.” (FAPRI/CARD, 2005).

Another assumption made in the FAPRI/CARD model is that trade in seeds, oil, and meal is an excess demand/supply and provides market closure. For each commodity, world price adjusts to clear the world market and ensure that the sum of excess demands over all countries is zero. The FARPRI/CARD model is also linked to other FAPRI model components in their livestock and commodities models.

Economics Research Service/Penn State Trade Model

The USDA-Economic Research Service (ERS)/Penn State Trade Model is a multiple-commodity, multiple-region model of agricultural policy and trade. Their model does not distinguish a region's imports by their source or a region's exports by their destination. The model is a gross trade model that accounts for exports and imports of each commodity in every region. The ERS/Penn State Trade Model incorporates 12 countries/regions and 35 commodities as shown in Table 4 (Abler, 2005). In addition, the model also includes both general policy and country specific components. General policy components include specific and ad valorem import and export taxes/subsidies, tariff-rate quotas (TRQs), and producer and consumer subsidies. Country specific components include the U.S. loan rate; production quotas for milk for Canada; producer target prices, producer compensation schemes for Japan and South Korea; intervention
prices, variable import levies, compensatory payments, acreage set-asides, base area bounds, and production quotas for raw milk and sugar in the European Union.

Table 4. Country and Commodity Coverage of the ERS/Penn State Trade Model

<table>
<thead>
<tr>
<th>Country Coverage (12 countries/regions)</th>
<th>United States, European Union (EU-15), Japan, Canada, Mexico, Brazil, Argentina, China, Australia, New Zealand, South Korea, and a region for the rest of the world (ROW).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commodity Coverage</td>
<td></td>
</tr>
<tr>
<td>13 commodities</td>
<td>rice, wheat, corn, other coarse grains (barley, sorghum, millet, and oats), soybeans, sunflower seed, rapeseed, peanuts, cotton, other oilseeds (canola, flax seed, and others), tropical oils, and sugar</td>
</tr>
<tr>
<td>12 oilseed products</td>
<td>soybean oil and meal, sunflower seed oil and meal, rapeseed oil and meal, cottonseed oil and meal, peanut oil and meal, other oilseed oil and meal</td>
</tr>
<tr>
<td>4 livestock products</td>
<td>beef and veal (combined), pork, poultry, raw milk</td>
</tr>
<tr>
<td>6 processed dairy products</td>
<td>fluid milk, butter, cheese, nonfat dry milk, whole dry milk, and other dairy products (ice cream, yogurt, and whey)</td>
</tr>
</tbody>
</table>

The ERS/Penn State Trade Model adopted a reduced-form economic model in which the behavior of producers, consumers, and other economic agents is represented by elasticities and other model parameters. The elasticities used in this model are assumed to be constant and draw from other trade models, including the European Simulation Model (ESIM), the ERS baseline projections model, and the Food and Agricultural Policy Simulator (FAPSIM), among others.
CHAPTER FIVE
THEORETICAL MODEL

Introduction

As presented in Chapter two, globally, China is the number one soybean importer, and the U.S., Brazil, and Argentina are the top three soybean exporters. In 2004, Chinese soybean imports accounted for 35% of the world total, and soybean exports from the above three soybean exporting countries accounted for over 90% of the world total. Given the above aggregate market shares of these soybean traders in the world soybean market, the world soybean market may not be perfectly competitive. Focusing on the Chinese soybean import market, it may be characterized as either a monopsony where China, as the leading soybean importer, has stronger market power relative to the U.S., Brazil, and Argentina, or as an oligopoly where the U.S., Brazil, and Argentina, as the leading soybean suppliers, have relatively stronger market power than Chinese soybean importers. This research seeks to test who has stronger market power in the Chinese soybean import market, analyze its competitive structure, and compare competitiveness of the three soybean exporters.

To conduct the competitive structure analysis of the Chinese soybean import market, it is critical to know whether the market is characterized as either a monopsony or an oligopoly. Therefore, knowing the market power of different players in the Chinese soybean import market is a key factor in understanding the competitive structure of the market. To measure market power of soybean traders in the Chinese soybean import market, an inverse residual soybean supply, an inverse residual soybean demand, and a
two-country partial equilibrium soybean trade model, combining the inverse residual soybean supply and the inverse residual soybean demand, were developed, estimated, and compared in this research.

**Modification of the Lerner Index from the Exporters’ Perspective**

Following Carter, et al. (1999), assuming that 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. In addition, soybeans exported to China from different countries are assumed homogeneous products.

As shown in Figure 21, left panel, the Chinese residual soybean demand for country $i$’s ($i=$ the U.S, Brazil, and Argentina) soybeans equals the summation of the Chinese domestic soybean supply, $S_{CH}$; plus Chinese imports from countries other than country $i$, $IMP_{OTH}$; and the net change of soybean stocks in China, $STK_{CH}$; this cumulative supply minus the Chinese domestic soybean demand, $D_{CH}$. From the soybean exporting country’s perspective, it is assumed that soybean exporters in country $i$ face a downward sloping residual soybean demand curve $RD_{CH}^i$ as shown in Figure 21, right panel. The curve $MC_i$ in the right panel of Figure 21, is the marginal cost for soybean exporters in country $i$. To maximize soybean export profits, the soybean exporters in country $i$ choose point A in Figure 21, right panel, where marginal cost equals marginal revenue, as the optimal choice. Accordingly, the equilibrium export quantity is $Q_{XPT}^i$ at the equilibrium export price, $P_{XPT}^i$. The distance between A and B can be viewed as the mark-up for soybean exporters in country $i$. 

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Mathematically, soybean exporters in country $i$ choose export quantity to China, $Q_{i}^{XPT}$, to maximize their profits, $\pi_i$, 

$$Max_{Q_{i}^{XPT}} \pi_i = P_{i}^{XPT} (Q_{i}^{XPT}) - (P_{i}^{Farm} + C_i) \cdot Q_{i}^{XPT}$$  

where $i =$ the U.S., Brazil, and Argentina, and $\pi_i$ is profits obtained by soybean exporters in country $i$. The variable $P_{i}^{XPT}$ is the soybean export price by country $i$, which is a function of its export quantity, $Q_{i}^{XPT}$. The variable $P_{i}^{Farm}$ is the soybean farm level price in country $i$, or the exporters’ purchase cost from soybean farmers in country $i$, and $C_i$ is the soybean exporters’ transaction costs in country $i$.
The first order condition (FOC) gives

\[
\frac{\partial \pi_i}{\partial Q_{i}^{XPT}} = \left( \frac{\partial P_i^{XPT}}{\partial Q_{i}^{XPT}} * Q_{i}^{XPT} + P_i^{XPT} \right) - (P_i^{Farm} + C_i) = 0
\]

\[
\Rightarrow \left( \frac{\partial P_i^{XPT}}{\partial Q_{i}^{XPT}} * Q_{i}^{XPT} + P_i^{XPT} \right) - (P_i^{Farm} + C_i) = 0
\]

\[
\Rightarrow P_i^{XPT} - (P_i^{Farm} + C_i) = -\frac{\partial P_i^{XPT}}{\partial Q_{i}^{XPT}} * Q_{i}^{XPT}
\]

\[
(19) \Rightarrow \frac{P_i^{XPT} - (P_i^{Farm} + C_i)}{P_i^{XPT}} = -\frac{\partial P_i^{XPT}}{\partial Q_{i}^{XPT}} * \frac{Q_{i}^{XPT}}{P_i^{XPT}} = -\frac{\partial P_i^{XPT}}{\partial Q_{i}^{XPT}} / \frac{Q_{i}^{XPT}}{P_i^{XPT}}
\]

Comparing equation (19) with the Lerner Index, equation (5), the left hand side of equation (19) looks similar to the Lerner Index, \( LI = \frac{P - MC}{P} \). Defining

\[
\frac{P_i^{XPT} - (P_i^{Farm} + C_i)}{P_i^{XPT}} \quad \text{as the Adjusted Lerner Index for country } i \ (ALI_i), \text{ the market power for soybean exporters in country } i \text{ over Chinese soybean importers can be measured by the Adjusted Lerner Index for country } i. \text{ The right hand side of equation (19) is the price flexibility of China’s inverse residual demand for soybeans from country } i. \text{ Therefore the price flexibility of China’s inverse residual demand for soybeans from country } i \text{ can be used as an indirect measure to evaluate market power of soybean exporters in country } i. \]
The next step is to derive the relationship between the soybean export price in
country \(i\), \(P_{i}^{XPT}\), and the farm level soybean price in country \(i\), \(P_{i}^{Farm}\). Consider equation
(19) above. Assuming that the unitary transaction costs of soybean exporters in country \(i\),
\(C_{i}\), are a constant ratio, \(\gamma_{i}\), of the country \(i\)’s farm level soybean price, \(P_{i}^{Farm}\), i.e.

\[
\gamma_{i} = \frac{C_{i}}{P_{i}^{Farm}},
\]

and set \(\theta_{i}^{CH} = \frac{\partial P_{i}^{XPT} / P_{i}^{XPT}}{\partial Q_{i}^{XPT} / Q_{i}^{XPT}}\), which is the price flexibility of the Chinese
inverse residual demand for soybeans from country \(i\), then equation (19) can be written as

\[
\frac{P_{i}^{XPT} - (P_{i}^{Farm} + \gamma_{i} P_{i}^{Farm})}{P_{i}^{XPT}} = -\theta_{i}^{CH}
\]

\[
\Rightarrow P_{i}^{XPT} - (1 + \gamma_{i}) P_{i}^{Farm} = -\theta_{i}^{CH} * P_{i}^{XPT}
\]

\[
\Rightarrow (1 + \theta_{i}^{CH}) * P_{i}^{XPT} = (1 + \gamma_{i}) P_{i}^{Farm}
\]

(20) \[\Rightarrow P_{i}^{Farm} = \frac{(1 + \theta_{i}^{CH})}{(1 + \gamma_{i})} P_{i}^{XPT}\]

(21) \[\text{Set } \phi_{i} = \frac{(1 + \theta_{i}^{CH})}{(1 + \gamma_{i})}\]

Then equation (20) can be written as

(22) \[P_{i}^{Farm} = \phi_{i} P_{i}^{XPT}\]

Equation (22) indicates a linear relationship between the farm level price and the export
price in country \(i\), assuming that in the short-run, the price flexibility of the Chinese
inverse residual demand is constant.
Modification of the Lerner Index from the Importers’ Perspective

From the Chinese soybean importers’ side, facing exporting country $i$’s upward sloping residual soybean supply, Chinese soybean importers choose an optimal import quantity to maximize their import profits.

The curve $RS_{i}^{CH}$, in the left panel of Figure 22, is exporting country $i$’s residual soybean supply for China, which equals the exporting country $i$’s domestic supply, $S_{i}$; minus domestic demand, $D_{i}$; minus exports to countries other than China, $XPT_{OTH}$; minus the change of soybean stocks in exporting country $i$, $\Delta STK_{i}$. To maximize Chinese import profits, facing the residual soybean supply curve, $RS_{i}^{CH}$, Chinese soybean importers choose point C in Figure 22, left panel, where Chinese soybean importers’ marginal revenue, $MR_{CH}$, equals their marginal import costs, $MC_{CH}$.

Accordingly, China’s equilibrium import quantity is $Q_{CH}^{i,IMP}$ at the equilibrium import price $P_{CH}^{i,IMP}$.

Mathematically, Chinese soybean importers choose import quantity from exporting country $i$, $Q_{CH}^{i,IMP}$, to maximize their import profits, $\pi_{CH}^{i}$:

$$\text{Max } \pi_{CH}^{i} = \frac{P_{CH}}{ER_{CH}} \cdot Q_{CH}^{i,IMP} - [(1 + t)P_{CH}^{i,IMP}(Q_{CH}^{i,IMP}) + C_{CH}] \ast Q_{CH}^{i,IMP}$$

where $\pi_{CH}^{i}$ is the import profits obtained by Chinese soybean importers, and $P_{CH}$ is the Chinese domestic soybean retail price. The variable $P_{CH}^{i,IMP}$ is the Chinese soybean import price from exporting country $i$, and $Q_{CH}^{i,IMP}$ is the Chinese soybean import quantity.
from exporting country $i$. The variable $ER_{CH}$ is the exchange rate, $t$ is the Chinese import tariff rate \textit{(ad valorem)} on soybean imports, and $C_{CH}$ is the transaction costs paid by Chinese soybean importers.

\begin{equation}
\frac{\partial \pi^i_{CH}}{\partial Q^i_{CH}} = \frac{P_{CH}}{ER_{CH}} \left( (1 + t) \frac{\partial P^i_{CH}}{\partial Q^i_{CH}} * Q^i_{CH} + [(1 + t)P^i_{CH} + C_{CH}] \right) = 0
\end{equation}

\begin{align*}
\Rightarrow & \frac{P_{CH}}{ER_{CH}} \left( (1 + t) \frac{\partial P^i_{CH}}{\partial Q^i_{CH}} * Q^i_{CH} + [(1 + t)P^i_{CH} + C_{CH}] \right) = 0 \\
\Rightarrow & (P_{CH} / ER_{CH}) - C_{CH} - (1 + t)P^i_{CH} = (1 + t) \frac{\partial P^i_{CH}}{\partial Q^i_{CH}} * Q^i_{CH}
\end{align*}

Figure 22. Exporting Country $i$’s Residual Soybean Supply to China
\[
\frac{(P_{CH}/ER_{CH}) - C_{CH} - (1 + t)P_{i,IMP}^{CH}}{1 + t} = \frac{\partial P_{i,IMP}^{CH}}{\partial Q_{i,IMP}^{CH}} * Q_{i,IMP}^{CH} \\
(25) \quad \Rightarrow (P_{CH}/ER_{CH}) - C_{CH} - (1 + t)P_{i,IMP}^{CH} = \frac{\partial P_{i,IMP}^{CH}}{\partial Q_{i,IMP}^{CH}} * \frac{Q_{i,IMP}^{CH}}{P_{i,IMP}^{CH}} = \frac{\partial P_{i,IMP}^{CH}}{\partial Q_{i,IMP}^{CH}} / Q_{i,IMP}^{CH}
\]

Similar to equation (19), the left hand side of equation (25) looks similar to the Lerner Index, \( LI = \frac{P - MC}{P} \). Define \( \frac{(P_{CH}/ER_{CH}) - C_{CH} - (1 + t)P_{i,IMP}^{CH}}{(1 + t)P_{i,IMP}^{CH}} \) as the Adjusted Lerner Index for Chinese soybean importers, \( ALI_{i,CH} \), which can be used to measure monopsony power of Chinese soybean importers over soybean exporters in country \( i \).

The right hand side of equation (25) is the price flexibility of the country \( i \)'s inverse residual soybean supply for China. The market power of Chinese soybean importers can be measured indirectly by estimating the price flexibility of country \( i \)'s inverse residual soybean supply function for China.

The next step is to derive the relationship between the Chinese soybean import price from exporting country \( i \), \( P_{i,IMP}^{CH} \), and the Chinese domestic soybean retail price, \( P_{CH}^{RTL} \).

Reconsidering equation (25), the following is obtained

\[
(P_{CH}^{RTL}/ER_{CH}) - C_{CH} - (1 + t)P_{i,IMP}^{CH} = \frac{\partial P_{i,IMP}^{CH}}{\partial Q_{i,IMP}^{CH}} / P_{CH}^{i,IMP} \frac{P_{i,IMP}^{CH}}{Q_{i,IMP}^{CH}} (1 + t)P_{i,IMP}^{CH}
\]

\[
\Rightarrow P_{CH}^{RTL} / ER_{CH} = \frac{\partial P_{i,IMP}^{CH}}{\partial Q_{i,IMP}^{CH}} / P_{i,IMP}^{CH} Q_{i,IMP}^{CH} (1 + t)P_{i,IMP}^{CH} + C_{CH} + (1 + t)P_{i,IMP}^{CH}
\]
Similarly, assuming that transaction costs for Chinese soybean importers, $C_{CH}$, are a constant ratio, $\gamma_{CH}$, of the Chinese soybean import price, i.e. $\gamma_{CH} = \frac{C_{CH}}{P_{CH}^{i,IMP}}$ and setting $\theta_{CH}^{i} = \frac{\partial P_{CH}^{i,IMP}}{\partial Q_{CH}^{i,IMP}} \frac{Q_{CH}^{i,IMP}}{P_{CH}^{i,IMP}}$, which is the price flexibility of exporting country $i$’s inverse residual soybean supply function for China, and it can be used to measure the market power of Chinese soybean importers over soybean exporters in country $i$, then, the above equation becomes

$$P_{CH}^{RTL} = [(\theta_{CH}^{i} + 1)(1 + t)P_{CH}^{i,IMP} + \gamma_{CH}P_{CH}^{i,IMP}] \cdot ER_{CH}$$

(26)  $$\implies P_{CH}^{RTL} = [(1 + t)(1 + \theta_{CH}^{i}) + \gamma_{CH}] \cdot ER_{CH} \cdot P_{CH}^{i,IMP}$$

During the period of this research (January 1999—February 2005), the Chinese import tariffs on soybeans and the Chinese exchange rate to U.S. dollars were constant. Setting

$$\varphi_{CH} = [(1 + t)(1 + \theta_{CH}^{i}) + \gamma_{CH}] \cdot ER_{CH} \cdot 5.1$$

(27)  $$\implies P_{CH} = \varphi_{CH} \cdot P_{CH}^{i,IMP}$$

*5.1 Since China had a fixed exchange rate, which was pegged to the U.S. dollar, there were no changes in the Chinese exchange rate.
Equation (28) shows the relationship between the Chinese soybean import price from exporting country $i$, $P_{CH}^{Imp}$, and the Chinese domestic soybean retail price, $P_{CH}$.

**China’s Inverse Residual Soybean Demand Model**

As shown in Figure 21, the China’s residual demand for exporting country $i$’s soybeans equals the Chinese domestic demand for soybeans, $D_{CH}$; minus Chinese domestic soybean supply, $S_{CH}$; minus Chinese soybean imports from countries other than country $i$, $IMP_{CH}^{OTH}$; plus the net change of Chinese soybean stocks, $STK_{CH}$.

Mathematically, the Chinese residual demand function for exporting country $i$’s soybeans can be written as

$$RD_{CH}^{i} = D_{CH} - (S_{CH} + IMP_{CH}^{OTH}) + \Delta STK_{CH}$$  \hspace{1cm} (29)$$

where the Chinese domestic demand and supply functions are defined as

$$D_{CH} = D_{CH}(P_{CH}; Z_{CH}^{D})$$  \hspace{1cm} (30)$$

$$S_{CH} = S_{CH}(P_{CH}; Z_{CH}^{S})$$  \hspace{1cm} (31)$$

where the variable $P_{CH}$ is the Chinese domestic soybean retail price, $Z_{CH}^{D}$ is a vector of Chinese demand shifters, including the prices of substitutes or complements, income, population, among others; and $Z_{CH}^{S}$ is a vector of Chinese supply shifters, including prices of substitutes or complements, technology, production costs, among others. Chinese imports from countries other than country $i$ and Chinese stocks of soybeans are considered as exogenous variables in this research.
Substituting the Chinese soybean domestic demand (equation (30)) and the Chinese domestic supply (equation (31)) into the Chinese residual demand for exporting country i’s soybeans (equation (29)), and writing it in its implicit form, equation (29) becomes

\[ RD_i^i = RD(P_{CH}, Z_{CH}^D, Z_{CH}^s, IMP_{CH}^{OTH}, \Delta STK_{CH}) \]

Chapter 2 reviewed Chinese biotech policies and their impacts on soybean trade. To test the impacts of Chinese biotech policies on soybean exports to China, a dummy variable, the Chinese biotech policy, \( BP^{CH} \), is added to this model, then equation (32) becomes

\[ RD_i^i = RD(P_{CH}, Z_{CH}^D, Z_{CH}^s, IMP_{CH}^{OTH}, \Delta STK_{CH}, BP_{CH}) \]

Considering the relationship between the Chinese soybean import price from exporting country i and the Chinese domestic soybean retail price, equation (28) is substituted into equation (33) to obtain

\[ RD_i^i = RD(P_{CH}^{IMP}, Z_{CH}^D, Z_{CH}^s, IMP_{CH}^{OTH}, \Delta STK_{CH}, BP_{CH}) \]

Writing equation (34) in its inverse form, it becomes

\[ P_{CH}^{IMP} = P_{CH}^{IMP}(RD_i^i; Z_{CH}^D, Z_{CH}^s, IMP_{CH}^{OTH}, \Delta STK_{CH}, BP_{CH}) \]

Equation (35) is the Chinese inverse residual demand function for exporting country i’s soybeans.
Exporting Country i’s Inverse Residual Soybean Supply Model

As shown in Figure 22, exporting country i’s residual soybean supply to China equals the domestic soybean supply in exporting country i, \( S_i \); minus its domestic soybean demand, \( D_i \); minus the soybean exports to countries other than China, \( XPT^{OTH}_i \); plus the net change of soybean stocks, \( \Delta STK_i \). Mathematically, exporting country i’s residual soybean supply function to China can be written as

\[
RS_i^{CH} = S_i - (D_i + XPT^{OTH}_i) + \Delta STK_i
\]

Where domestic demand and supply functions in exporting country i are defined as

\[
D_i = D(P_{Farm}^i; Z_i^D) \tag{37}
\]

\[
S_i = S(P_{Farm}^i; Z_i^S) \tag{38}
\]

The variable \( P_{Farm}^i \) is the farm level soybean price in exporting country i, \( Z_i^D \) is a vector of demand shifters in exporting country i, including prices of substitutes or complements, income, population, among others; and \( Z_i^S \) is a vector of supply shifters in country i, including the prices of substitutes or complements, technology, production costs, among others. The soybean exports from country i to countries other than China, \( XPT^{OTH}_i \), and the soybean stock changes, \( \Delta STK_i \), are considered as exogenous variables.

\footnote{Assuming a constant marketing margin between the U.S. soybean retail price and the U.S. farm level price, the U.S. farm level price can be used in the U.S. domestic demand function instead of the U.S. soybean retail price for estimation purposes.}
Substituting domestic soybean supply (equation (38)) and domestic soybean demand (equation (37)) into exporting country \(i\)'s residual soybean supply function for China (equation (36)) and writing it in its implicit form, equation (36) becomes

\[
RS_i^{CH} = RS(P_{farm}^i, Z_i^S, Z_i^D, XPT_i^{OTH}, \Delta STK_i)
\]

Considering the relationship between the soybean export price for China and the farm level soybean price in exporting country \(i\), substituting equation (22) into equation (39) results in

\[
RS_i^{CH} = RS(P_{XPT}^i, Z_i^S, Z_i^D, XPT_i^{OTH}, \Delta STK_i)
\]

Writing equation (40) in its inverse form as

\[
P_{XPT}^i = P_{XPT}^i (RS_i^{CH}, Z_i^S, Z_i^D, XPT_i^{OTH}, \Delta STK_i)
\]

Equation (41) is exporting country \(i\)'s inverse residual soybean supply function to China.

**The Two-Country Partial Equilibrium Trade Model**

Assuming other source countries for Chinese imported soybeans and destination countries of country \(i\)'s soybean exports are exogenous factors, a two-country partial equilibrium trade model can be specified

\[
\begin{align*}
(35) & & P_{CH}^{i,IMP} = P_{CH}^{i,IMP} \left( RD_{CH}^i, Z_{CH}^D, Z_{CH}^S, IMP_{CH}^{OTH}, \Delta STK_{CH}, BP_{CH} \right) \\
(41) & & P_{XPT}^i = P_{XPT}^i (RS_i^{CH}, Z_i^S, Z_i^D, XPT_i^{OTH}, \Delta STK_i) \\
(42) & & RD_{CH}^i = RS_i^{CH} \\
(43) & & P_{CH}^{i,IMP} = P_{CH}^{L,IMP} (P_{XPT}^i)
\end{align*}
\]

Where \(i\) = exporting countries: U.S., Brazil, and Argentina.
Equation (35) is the Chinese inverse residual demand function for exporting country $i$’s soybeans, and equation (41) is exporting country $i$’s inverse residual soybean supply function for China. Equation (42) is the equilibrium condition where, at equilibrium, the Chinese residual soybean demand for country $i$ equals exporting country $i$’s residual soybean supply for China. Equation (43) captures the relationship between the Chinese soybean import price and exporting country $i$’s soybean export price. Data used in this research for the Chinese soybean import price is CIF (Cost, Insurance, and Freight) price, which includes the transportation costs and insurance costs. Data for exporting country $i$’s soybean export price is FOB (Free on Board) price. Equation (43) reflects the information of transportation and insurance costs.
CHAPTER SIX

VARIABLE IDENTIFICATION

For empirical estimation purposes, variables in equation (35) and (41) will be identified and the specific functional form for China’s inverse residual demand model, exporting country i’s inverse residual supply model, and the two-country partial equilibrium trade model will be developed in this chapter.

China’s Inverse Residual Soybean Demand Model

Equation (35) includes four groups of variables. The first group is the Chinese soybean import quantity from exporting country \( i \) or the Chinese residual demand for country \( i \)’s soybeans, \( RD^i_{CH} \). The second group is Chinese domestic demand shifters, \( Z^D_{CH} \). Theoretically, demand shifters include income, population, prices of substitutes and complements, and consumers’ preferences, among others. In this research, demand shifters for Chinese domestic soybeans include: the price of corn in the Chinese domestic market, \( P^{Corn}_{CH} \), assuming that corn is a substitute for soybeans for both soybeans and corn can be used for feed and oil, the Chinese personal disposable income, \( INC_{CH} \), and the livestock development index, \( LDI_{CH} \), since soybeans can be crushed into soymeal, which is mainly used for feed.

In regards to the variable \( LDI_{CH} \), the Chinese livestock industry has developed rapidly in recent years, whereby soymeal is a main feed material for Chinese livestock. As presented in Chapter two, in 2004, about 74% or 28 million metric tons of soybeans were crushed in China and soymeal from crushed soybeans are mainly used for feed.
purposes. The development of the livestock industry in China spurred an increasing
demand for soymeal, which led to an increase in soybean demand. The livestock
development index, $LDI_{CH}$, was developed by calculating the chain growth rate of
Chinese total meat output. Meats used to calculate this index include beef, pork, poultry,
and fish. In addition, the Chinese domestic soybean product prices -- soyoil price, $P_{CH}^{Oil}$,
and soymeal price, $P_{CH}^{Oil}$ -- were also included in the model.

The third group is Chinese soybean supply shifters. Theoretically, supply shifters
include production costs, the prices of substitutes or complements, and technology,
among others. In this research, supply shifters of Chinese soybeans include the corn
price in the Chinese domestic market, $P_{CH}^{Corn}$. Similarly, as in the Chinese domestic
soybean demand model, corn is assumed to be a substitute for soybeans. Another
variable included in the Chinese domestic soybean supply model is technology, measured
by the time trend variable, $T$. Production costs are not included in the model. Data used
in this research is monthly data. However, data for production costs for soybeans is
yearly data. Production costs are not included in the model to avoid a multicollinearity
problem with time trend variable.

The last group includes Chinese soybean imports from other countries, $IMP_{OTH}^{CH}$,
and the Chinese biotech policy, $BP_{CH}$. For the variable representing Chinese biotech
policy, as discussed in Chapter three, China passed its first biotech product regulation in
May 2001. Therefore, in this research, the variable $BP_{CH}$ equals 0 before May 2001 and
1 otherwise. Since Chinese soybean stocks are very low and have not changed much
during the period of this research (January 1999—February 2005), changes of the 
Chinese soybean stocks are not included in this model.

Based on the theoretical model and the above analysis, the specific functional 
form of the Chinese inverse residual demand for exporting country $i$’s soybeans is written as

$$
P^{i,IMP}_{CH} = a_0 + aRD_{CH}^i + a_1P_{CH}^{Corn} + a_2INC_{CH} + a_3LDI_{CH} + a_4P_{CH}^{Oil} + a_5P_{CH}^{Meal} + a_6T + a_7IMP_{CH}^{OTH} + a_8BP_{CH} + \epsilon_{CH}
$$

(44)

Definitions of the variables in equation (44), including units, where $\$ equals U.S. dollars, 
MT equals metric tons, and RMB equals Chinese yuan, are listed as follows.

- $P^{i,IMP}_{CH}$: The Chinese soybean import price from exporting country $i$ ($/MT)$;
- $RD_{CH}^i$: The Chinese residual demand for exporting country $i$’s soybeans (MT), or the 
Chinese soybean import quantity from exporting country $i$;
- $P_{CH}^{Corn}$: Chinese corn price (RMB/MT);
- $INC_{CH}$: Chinese personal disposable income (RMB);
- $LDI_{CH}$: The Chinese livestock industry development index, which is the growth rate of 
Chinese meat production, including pork, beef, poultry, and fish;
- $P_{CH}^{Oil}$: Chinese soyoil price (RMB/MT);
- $P_{CH}^{Meal}$: Chinese soymeal price (RMB/MT);
- $T$: Time trend variable, measuring technological progress;
$IMP_{CH}^{OTH}$: Chinese soybean imports from countries other than exporting country $i$ (MT);

$BP_{CH}$: Chinese biotech policy, a dummy variable, equaling 0 before May 2001 and 1 otherwise;

$\epsilon_{CH}$: Error term, assumed identically and independently distributed.

**Exporting Country $i$’s Inverse Residual Soybean Supply Model**

Similar to the Chinese inverse residual demand function for country $i$’s soybeans, exporting country $i$’s inverse residual soybean supply function for China, equation (41), also includes five groups of variables. The first group is the soybean export quantity from country $i$ to China, or exporting country $i$’s residual soybean supply for China, $RS_{i}^{CH}$. The second group is soybean demand shifters in exporting country $i$, including personal disposable income within country $i$, $INC_i$; the domestic price of corn in country $i$, $P_{i,Corn}^{Corn}$, a substitute for soybeans; the soyoil price in country $i$, $P_{i,Oil}^{Oil}$; and the soymeal price in country $i$, $P_{i,Meal}^{Meal}$. The third group is soybean supply shifters for exporting country $i$, including technology, measured by the time trend variable, $T$, and the price of corn in country $i$, $P_{i,Corn}^{Corn}$. The fourth group is country $i$’s soybean exports to countries other than China, $XPT_{i}^{OTH}$. The last group is country $i$’s soybean beginning stocks, $STK_i$.

Then, based upon the theoretical model and the above analysis, the specific functional form of exporting country $i$’s inverse residual soybean supply function for China can be written as

$$P_{i,XPT} = \beta_0 + \beta RS_{i}^{CH} + \beta_1 P_{i,Corn}^{Corn} + \beta_2 INC_i + \beta_3 P_{i,Oil}^{Oil} + \beta_4 P_{i,Meal}^{Meal} + \beta_5 T$$

$$+ \beta_6 XPT_{i}^{OTH} + \beta_7 STK_i + \epsilon_i$$

(45)
where $P_{i}^{XPT}$: Exporting country $i$’s soybean export price to China ($/MT);

$RS_{i}^{CH}$: Exporting country $i$’s residual soybean supply for China, or country $i$’s soybean exports to China (MT);

$INC_{i}$: Personal disposable income for exporting country $i$ ($);

$P_{i}^{Corn}$: Corn price in country $i$ ($/MT);

$P_{i}^{Oil}$: Soyoil price in country $i$ ($/MT);

$P_{i}^{Meal}$: Soymeal price in country $i$ ($/MT);

$XPT_{i}^{OTH}$: Soybean exports from country $i$ to countries other than China (MT);

$STK_{i}$: Beginning soybean stocks in country $i$ (MT);

$\varepsilon_{i}$: Error term, assumed identically and independently distributed.

**Two-Country Partial Equilibrium Trade Model**

Combining China’s inverse residual demand for exporting country $i$’s soybean (equation (44)) and exporting country $i$’s inverse residual soybean supply for China (equation (45)), and incorporating the equilibrium condition, where China’s residual demand for exporting country $i$’s soybeans equals exporting country $i$’s residual soybean supply to China, i.e., $RD_{CH}^{i} = RS_{i}^{CH}$, the specific functional form of the two-country partial equilibrium trade model can be written as
\[
P_{i,\text{IMP}}^{CH} = \alpha_0 + aRDi^{CH} + \alpha_1P_{i,\text{Corn}}^{CH} + \alpha_2INC_{i,\text{CH}} + \alpha_3LDI_{i,\text{CH}} + \alpha_4P_{i,\text{Oil}}^{CH} \\
+ \alpha_5P_{i,\text{Meal}}^{CH} + \alpha_6T + \alpha_7IMP_{i,\text{OTH}}^{CH} + \alpha_8BP_{i,\text{CH}} + \varepsilon_{CH}
\]

\[
P_{i}^{XPT} = \beta_0 + \beta RS_{i}^{CH} + \beta_1P_{i,\text{Corn}}^{CH} + \beta_2INC_{i} + \beta_3P_{i,\text{Oil}}^{CH} + \beta_4P_{i,\text{Meal}}^{CH} + \beta_5T \\
+ \beta_6XPT_{i,\text{OTH}}^{CH} + \beta_7STK_{i} + \varepsilon_{i}
\]

\[
RD_{i}^{CH} = RS_{i}^{CH}
\]

\[
P_{i,\text{IMP}}^{CH} = \phi_0 + \phi_1P_{i}^{XPT}
\]

where i = exporting countries: the U.S., Brazil, and Argentina.

Assuming that in the short-run, the price flexibility of either the Chinese inverse residual demand for exporting country i’s soybeans or exporting country i’s inverse residual soybean supply to China is constant, then equations (42)-(45) can be estimated by the double-log or semi-log form as shown by equations (46) to (49).

\[
\ln P_{i,\text{IMP}}^{CH} = \alpha_0 + \theta_{i,\text{CH}} \ln RD_{i}^{CH} + \alpha_1\ln P_{i,\text{Corn}}^{CH} + \alpha_2\ln PINC_{i,\text{CH}} + \alpha_3\ln LDI_{i,\text{CH}} \\
+ \alpha_4\ln P_{i,\text{Oil}}^{CH} + \alpha_5\ln P_{i,\text{Meal}}^{CH} + \alpha_6\ln T + \alpha_7\ln IMP_{i,\text{OTH}}^{CH} + \alpha_8\ln BP_{i,\text{CH}} + \varepsilon_{CH}
\]

\[
\ln P_{i}^{XPT} = \beta_0 + \beta_1^{CH} \ln RS_{i}^{CH} + \beta_1\ln P_{i,\text{Corn}}^{CH} + \beta_2\ln PINC_{i} + \beta_3\ln P_{i,\text{Oil}}^{CH} \\
+ \beta_4\ln P_{i,\text{Meal}}^{CH} + \beta_5\ln T + \beta_6\ln XPT_{i,\text{OTH}}^{CH} + \beta_7\ln STK_{i} + \varepsilon_{i}
\]

\[
\ln RD_{i}^{CH} = \ln RS_{i}^{CH}
\]

\[
\ln P_{i,\text{IMP}}^{CH} = \phi_0 + \phi_1\ln P_{i}^{XPT}
\]

where i = exporting countries: the U.S., Brazil, and Argentina.
The equation system, equations (46) to (49), is the finalized specific functional form of the two-country partial equilibrium soybean trade model.
CHAPTER SEVEN
EMPIRICAL ESTIMATION AND INTERPRETATION

Introduction

Since most of the data for Brazil and Argentina are not available, only the U.S.-China partial equilibrium soybean trade model (equation system (46-49) is estimated in this research.

Data Description

Data used in this research are monthly data from January 1999 to February 2005, 74 observations. The variables used in this research and their sources are listed in Table 5. For China’s inverse residual soybean demand model, the variables for Chinese soybean residual demand, $RD_{CH}^{US}$, U.S. residual soybean supply, $RS_{US}^{CH}$, are from the Chinese Minister of Agriculture (MOA, 2006). The variable Chinese soybean import price is a derived price—Chinese soybean import value (Cost Insurance and Freight (CIF) value) divided by import quantity, and is also obtained from the Chinese Minister of Agriculture. The variable Chinese corn price, soyoil price and soymeal price are from Shanghai JC Intelligence Co., Ltd. (2005).

The variable Chinese personal disposable income comes from the U.S. Department of Agriculture, Economics Research Service (USDA-ERS)—International Macroeconomic Data Set (USDA-ERS, 2006). The raw data for Chinese personal disposable incomes are annual data. However, in this research, monthly data is required. To include personal disposable income in this model, the personal disposable income was transformed into monthly format, as described below.
### Table 5. Variables and Their Sources

<table>
<thead>
<tr>
<th>Variable</th>
<th>Meaning</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_{US,IMP}^{CH}$</td>
<td>Chinese soybean import price from the United States (RMB/MT);</td>
<td>The Chinese Minister of Agriculture.</td>
</tr>
<tr>
<td>$RD_{US}^{CH}$</td>
<td>Chinese residual demand for U.S. soybeans (MT);</td>
<td>The Chinese Minister of Agriculture.</td>
</tr>
<tr>
<td>$P_{CORN}^{CH}$</td>
<td>Chinese corn price at Dalian Port (RMB/MT);</td>
<td>Shanghai JC Intelligence Co., Ltd.</td>
</tr>
<tr>
<td>$INC_{CH}$</td>
<td>Chinese personal disposable income (RMB);</td>
<td>USDA-ERS.</td>
</tr>
<tr>
<td>$LDI_{CH}$</td>
<td>Chinese livestock industry development index;</td>
<td>Chinese Statistics Yearbook (1999-2005).</td>
</tr>
<tr>
<td>$P_{OIL}^{CH}$</td>
<td>Chinese soyoil prices (RMB/MT);</td>
<td>Shanghai JC Intelligence Co., Ltd.</td>
</tr>
<tr>
<td>$P_{MEAL}^{CH}$</td>
<td>Chinese soymeal prices (RMB/MT);</td>
<td>Shanghai JC Intelligence Co., Ltd.</td>
</tr>
<tr>
<td>$IMP_{BR}^{CH}$</td>
<td>Chinese soybean imports from Brazil (MT);</td>
<td>The Chinese Minister of Agriculture.</td>
</tr>
<tr>
<td>$IMP_{AR}^{CH}$</td>
<td>Chinese soybean imports from Argentina (MT);</td>
<td>The Chinese Minister of Agriculture.</td>
</tr>
<tr>
<td>$P_{EXP}^{US}$</td>
<td>U.S. soybean export price to China ($/MT);</td>
<td>USDA-FAS.</td>
</tr>
<tr>
<td>$RS_{US}^{CH}$</td>
<td>U.S. soybean residual supply for China (MT);</td>
<td>The Chinese Minister of Agriculture.</td>
</tr>
<tr>
<td>$INC_{US}$</td>
<td>U.S. personal disposable income ($);</td>
<td>USDA-ERS.</td>
</tr>
<tr>
<td>$P_{CORN}^{US}$</td>
<td>U.S. corn retail price at Chicago market ($/MT);</td>
<td>USDA-ERS.</td>
</tr>
<tr>
<td>$P_{OIL}^{US}$</td>
<td>U.S. soyoil price ($/MT);</td>
<td>USDA-ERS.</td>
</tr>
<tr>
<td>$P_{MEAL}^{US}$</td>
<td>U.S. soymeal price ($/MT);</td>
<td>USDA-ERS.</td>
</tr>
<tr>
<td>$XPT_{EU}^{US}$</td>
<td>U.S. soybean exports to the EU (MT);</td>
<td>USDA-FAS.</td>
</tr>
<tr>
<td>$XPT_{JP}^{US}$</td>
<td>U.S. soybean exports to Japan (MT);</td>
<td>USDA-FAS.</td>
</tr>
<tr>
<td>$XPT_{MX}^{US}$</td>
<td>U.S. soybean exports to Mexico (MT);</td>
<td>USDA-FAS.</td>
</tr>
<tr>
<td>$STK_{US}$</td>
<td>U.S. soybean beginning stocks (MT).</td>
<td>USDA-ERS.</td>
</tr>
</tbody>
</table>
To transform the personal disposable income from annual form to monthly form, the average growth rate, consistence, and precision were taken into consideration. First, the annual growth rate of Chinese personal disposable income was calculated. Second, an initial value was set as the January income. Then the calculated annual growth rate and the assumed initial value were used to estimate the incomes of the remaining months of the year. Next step is by using trial-and-error method to adjust the January income to ensure that the sum of the estimated income for each month equals the actual annual income. Figure 23 compares the actual annual data and the estimated monthly data for Chinese personal disposable income. Figure 23 indicates that the estimated monthly data has a similar trend as the actual annual data, statistically, the estimated monthly income can be used as an approximate to the real monthly income in the empirical estimation.

The variable Chinese livestock development index, $LDI_{CH}$, is developed by calculating the annual growth rate of Chinese total meat output, including beef, pork, and poultry, and fish\footnote{Although fish does not belong to the livestock industry, feed for fish also contains a great amount of soymeal. Therefore, when calculating the livestock development index, I also included fish meat in the total meat output.}. The actual data of meat output is annual data from the Chinese Statistics Yearbook, 1999-2005 (Chinese National Bureau of Statistics, 2005). The same method is used to transform the actual annual data into estimated monthly data. The estimated monthly data was used as an approximate of the real monthly data. Then the monthly growth rate of the estimated meat output is calculated as an index to reflect the demand change in feed due to rapid development of the Chinese livestock industry, $LDI_{CH}$. 
The variable Chinese soybean imports from other countries, \( IMP_{CH}^{OTH} \), includes two countries—Brazil and Argentina. So in the specific functional form of the Chinese inverse residual demand model, the variable \( IMP_{CH}^{OTH} \) is divided into two variables: Chinese soybean imports from Brazil, \( IMP_{CH}^{BR} \), and Chinese soybean imports from Argentina, \( IMP_{CH}^{AR} \). Data for these two variables are also from the Chinese Minister of
Agriculture. After dividing the variable $IMP_{CH}^{OTH}$ into two variables: $IMP_{CH}^{BR}$ and $IMP_{CH}^{AR}$, China’s inverse residual demand for U.S. soybean model (equation 46) becomes

$$
LnP_{CH}^{US,IMP} = \alpha_0 + \theta_{CH}^{US} LnRD_{CH}^{US} + \alpha_1 LnP_{CH}^{Corn} + \alpha_2 LnPINC_{CH} + \alpha_3 LnLDI_{CH} + \alpha_4 LnP_{CH}^{OIl} + \alpha_5 LnP_{CH}^{Meal} + \alpha_6 LnT + \alpha_7 LnIMP_{CH}^{BR} + \alpha_8 LnIMP_{CH}^{AR} + \alpha_9 BP_{CH} + \epsilon_{CH}
$$

(50)

For the U.S. inverse residual soybean supply to China model, the variables U.S. soybean export price to China is a derived price (FOB price) obtained by dividing the total monthly value of U.S. soybean exports by the total monthly volume of U.S. soybean exports. Data for U.S. soybean export value and volume were obtained from the U.S. Department of Agriculture, Foreign Agriculture Service (USDA-FAS, 2006)—U.S. Trade Internet System. The variable U.S. personal disposable income comes from USDA-ERS, International Macroeconomic Data Set (2006). Similar to Chinese personal disposable income, the raw data of U.S. personal disposable income is annual data. Using the same method as used for Chinese personal disposable income, U.S. monthly personal disposable income is estimated from the actual annual income. Figure 24 compares the actual annual data and the estimated monthly data for U.S. personal disposable income, and it shows that the estimated monthly data has the similar trend as the actual annual data.
Figure 24. U.S. Personal Disposable Income: Annual and Monthly

The variable the U.S. corn price comes from USDA-ERS, Feed Outlook Report from 1995 to 2005 (USDA-ERS, 2005b). The variables U.S. soyoil price, U.S. soymeal price, and U.S. soybean stocks come from USDA-ERS, Oil Crops Yearbook from 2002-2005 (USDA-ERS, 2005c). The variable U.S. soybean exports to countries other than China, $EX_P^{OTH}$, is divided into three variables: U.S. soybean exports to the EU, $EX_P^{EU}$,
U.S. soybean exports to Japan, $EXP_{US}^{JP}$, and U.S. soybean exports to Mexico, $EXP_{US}^{MX}$.

Data for these three variables come from USDA-FAS—U.S. Trade Internet System (USDA-FAS, 2006). After dividing the variable $EXP_{US}^{OTH}$ into variables: $EXP_{US}^{EU}$, $EXP_{US}^{JP}$, and $EXP_{US}^{MX}$, U.S. inverse residual soybean supply for China model (equation 47) becomes

\[
LnP_{US}^{XPT} = \beta_0 + \theta_{US}^{CH} LnRS_{US}^{CH} + \beta_1 LnP_{US}^{Corn} + \beta_2 LnPINC_{US} + \beta_3 LnP_{US}^{Oil} \\
+ \beta_4 LnP_{US}^{Meal} + \beta_5 LnT + \beta_6 LnXPT_{US}^{EU} + \beta_7 LnXPT_{US}^{JP} \\
+ \beta_8 LnXPT_{US}^{MX} + \beta_9 LnSTK_{US} + \varepsilon_{US} 
\]

(51)

Then the U.S.-China partial equilibrium soybean trade model (equations 46-49) becomes

\[
\begin{align*}
LnP_{CH}^{US,IMP} &= \alpha_0 + \theta_{CH}^{US} LnRS_{CH}^{US} + \alpha_1 LnP_{CH}^{Corn} + \alpha_2 LnPINC_{CH} + \alpha_3 LnLDI_{CH} \\
&\quad + \alpha_4 LnP_{CH}^{Oil} + \alpha_5 LnP_{CH}^{Meal} + \alpha_6 LnT + \alpha_7 LnIMP_{CH}^{BR} + \alpha_8 LnIMP_{CH}^{AR} \\
&\quad + \alpha_9 BP_{CH} + \varepsilon_{CH} \\
LnP_{US}^{XPT} &= \beta_0 + \theta_{US}^{CH} LnRS_{US}^{CH} + \beta_1 LnP_{US}^{Corn} + \beta_2 LnPINC_{US} + \beta_3 LnP_{US}^{Oil} \\
&\quad + \beta_4 LnP_{US}^{Meal} + \beta_5 LnT + \beta_6 LnXPT_{US}^{EU} + \beta_7 LnXPT_{US}^{JP} \\
&\quad + \beta_8 LnXPT_{US}^{MX} + \beta_9 LnSTK_{US} + \varepsilon_{US} \\
LnRD_{CH}^{US} &= LnRS_{US}^{CH} \\
LnP_{CH}^{US,IMP} &= \phi_0 + \phi_1 LnP_{US}^{XPT}
\end{align*}
\]

(50)  (51)  (52)  (53)

**Specification Test**

Before estimating the U.S.-China partial equilibrium soybean trade model, heteroskedasticity, autocorrelation, and multicollinearity tests are conducted for both
China’s inverse residual demand function for U.S. soybeans (equation 50) and U.S. inverse residual soybean supply function for China (equation 51).

Heteroskedasticity Test

White’s test (White 1980) is used to test the heteroskedasticity problems for both China’s inverse residual demand function for U.S. soybeans (equation 50) and U.S. inverse residual soybean supply function for China (equation 51). The residuals of estimation are used to investigate the heteroskedasticity of the true disturbances. The null hypothesis for White’s test is

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

SAS “proc model” procedure gives the test results when the option “White” is given (SAS, v.8.02). Test results, shown in Table 6, indicate that the null hypothesis for equation (50) and (51) cannot be rejected for both models. These test results imply that both China’s inverse residual demand function and U.S. inverse residual soybean supply function do not encounter the heteroskedasticity problem.

Table 6. White’s Test Results for Heteroskedasticity

<table>
<thead>
<tr>
<th>Function</th>
<th>White's Test Statistic</th>
<th>Critical Value</th>
<th>Pr&gt;ChiSq</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>The China’s inverse residual demand function for U.S. soybeans (equation 50)</td>
<td>63.13</td>
<td>67.5</td>
<td>0.2687</td>
<td>Fail to reject H₀.</td>
</tr>
<tr>
<td>The U.S. inverse residual soybean supply function for China (equation 51)</td>
<td>62.81</td>
<td>67.5</td>
<td>0.3097</td>
<td>Fail to reject H₀.</td>
</tr>
</tbody>
</table>
Autocorrelation Test

Autocorrelation problem was tested by testing the correlation of the current residual and the lagged residual obtained from the ordinary least square estimation (OLS). First, initial residuals were obtained by OLS estimation (by SAS). Next step is running regression of the current residual $e_t$ on the lagged residual $e_{t-1}$ to test whether the parameter of $e_{t-1}$ is significant or not. Mathematically,

$$e_t = c_0 + c_1 e_{t-1} + u$$

where $e_t$ is the residual from the OLS estimation, and $e_{t-1}$ is the lagged residual.

Hypothesis to be tested is

$H_0$: $c_1 = 0$, $H_a$: $c_1 \neq 0$.

Test results for both China’s inverse residual demand function (equation 50) and U.S. inverse residual supply function (equation 51), shown in Table 7, imply that the null hypothesis for China’s inverse residual demand function, cannot be rejected. However, the null hypothesis for U.S. inverse residual supply function is rejected. These test results indicate that China’s inverse residual demand function does not appear to encounter the autocorrelation problem, while the U.S. inverse residual soybean supply function does have autocorrelation. To improve empirical estimation results, the autocorrelation problem for the U.S. inverse residual soybean supply function need to be corrected.
Table 7. Test Results for Autocorrelation

| Function |
|------------------|-------------------|---------------|-------------------|-------------------|
| The Chinese inverse residual demand function for U.S. soybeans (equation 50) | Coefficient | Standard Error | T-value | Pr>ChiSq |
| -0.0041 | 0.1274 | -0.03 | 0.9743 | Fail to reject H₀. |
| The U.S. inverse residual soybean supply function for China (equation 51) | 0.357 | 0.1208 | 2.96 | 0.0044 | Reject H₀. |

Multicollinearity Test

Two methods are used to test for multicollinearity. The first one looks at the correlations among independent variables. If the correlation between two variables is very high, then the multicollinearity problem may be present.

Test results for China’s inverse residual demand function for U.S. soybeans, reported in Table 8, show that the correlation between the time trend variable, \( T \), and Chinese personal disposable income, \( INC_{CH} \), is 0.99 and the correlation between the time trend variable, \( T \), and the Chinese livestock development index, \( LDI_{CH} \), is 0.98. That means the time trend variable, \( T \), is possibly a problematic variable, which causes multicollinearity problem.
Table 8. Correlation between Independent Variables for the Chinese Inverse Residual Demand for U.S. Soybeans

<table>
<thead>
<tr>
<th>Correlation</th>
<th>$RD_{CH}^{US}$</th>
<th>$P_{CH}^{Corn}$</th>
<th>$INC_{CH}$</th>
<th>$LDI_{CH}$</th>
<th>$P_{CH}^{Oil}$</th>
<th>$P_{CH}^{Meal}$</th>
<th>$T$</th>
<th>$IMP_{CH}^{BR}$</th>
<th>$IMP_{CH}^{AR}$</th>
<th>$BP_{CH}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$RD_{CH}^{US}$</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$P_{CH}^{Corn}$</td>
<td>-0.11</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$INC_{CH}$</td>
<td>-0.06</td>
<td>0.62</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$LDI_{CH}$</td>
<td>-0.05</td>
<td>0.66</td>
<td>0.85</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$P_{CH}^{Oil}$</td>
<td>0.03</td>
<td>0.22</td>
<td>0.15</td>
<td>0.20</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$P_{CH}^{Meal}$</td>
<td>-0.03</td>
<td>0.58</td>
<td>0.78</td>
<td>0.82</td>
<td>0.38</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$T$</td>
<td>-0.05</td>
<td>0.63</td>
<td>0.99</td>
<td>0.98</td>
<td>0.04</td>
<td>0.78</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$IMP_{CH}^{BR}$</td>
<td>-0.25</td>
<td>0.27</td>
<td>0.36</td>
<td>0.34</td>
<td>0.01</td>
<td>0.35</td>
<td>0.38</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$IMP_{CH}^{AR}$</td>
<td>-0.32</td>
<td>0.11</td>
<td>0.30</td>
<td>0.29</td>
<td>-0.02</td>
<td>0.36</td>
<td>0.32</td>
<td>0.70</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>$BP_{CH}$</td>
<td>-0.14</td>
<td>0.58</td>
<td>0.87</td>
<td>0.83</td>
<td>-0.07</td>
<td>0.48</td>
<td>0.86</td>
<td>0.33</td>
<td>0.24</td>
<td>1</td>
</tr>
</tbody>
</table>

Test results for U.S. inverse residual soybean supply for China, reported in Table 9, show that the correlation between the time trend variable, $T$, and the U.S. personal disposable income, $INC_{US}$, is 0.96, which means that there is a possible collinearity problem between these two variables.

From this method, results indicate that for both China’s inverse residual demand function and U.S. inverse residual soybean supply, the time trend variable, $T$, might cause the multicollinearity problem.
Table 9. Correlation between Independent Variables for the U.S. Inverse Residual Soybean Supply for China

<table>
<thead>
<tr>
<th>Correlation</th>
<th>$RS_{US}^{CH}$</th>
<th>$INC_{US}$</th>
<th>$P_{US}^{Corn}$</th>
<th>$P_{US}^{Oil}$</th>
<th>$P_{US}^{Meal}$</th>
<th>$T$</th>
<th>$XPT_{US}^{EU}$</th>
<th>$XPT_{US}^{JP}$</th>
<th>$XPT_{US}^{MX}$</th>
<th>$STK_{US}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$RS_{US}^{CH}$</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$INC_{US}$</td>
<td>-0.03</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$P_{US}^{Corn}$</td>
<td>0.03</td>
<td>0.49</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$P_{US}^{Oil}$</td>
<td>-0.02</td>
<td>0.50</td>
<td>0.84</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$P_{US}^{Meal}$</td>
<td>0.01</td>
<td>0.62</td>
<td>0.70</td>
<td>0.67</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$T$</td>
<td>-0.05</td>
<td><strong>0.96</strong></td>
<td>0.63</td>
<td>0.63</td>
<td>0.64</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$XPT_{US}^{EU}$</td>
<td>0.50</td>
<td>-0.23</td>
<td>-0.08</td>
<td>-0.14</td>
<td>-0.15</td>
<td>-0.20</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$XPT_{US}^{JP}$</td>
<td>0.42</td>
<td>-0.12</td>
<td>-0.22</td>
<td>-0.20</td>
<td>-0.31</td>
<td>-0.15</td>
<td>0.59</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$XPT_{US}^{MX}$</td>
<td>0.20</td>
<td>-0.16</td>
<td>-0.22</td>
<td>-0.23</td>
<td>-0.27</td>
<td>-0.13</td>
<td>0.42</td>
<td>0.32</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>$STK_{US}$</td>
<td>0.49</td>
<td>-0.08</td>
<td>0.07</td>
<td>-0.11</td>
<td>0.07</td>
<td>-0.10</td>
<td>0.35</td>
<td>0.28</td>
<td>-0.01</td>
<td>1</td>
</tr>
</tbody>
</table>

The second method is the Condition Indices developed by Belsey, Kuh, and Welsch (1980). When the calculated condition index is around 10, weak dependencies may be starting to affect the regression estimates. When this number is larger than 100, the estimates may have a fair amount of numerical error (SAS, v8.02). In SAS, option COLLIN automatically tests multicollinearity problem and gives suggested variables which may cause multicollinearity problem. SAS estimation results for both China’s inverse residual demand function and U.S. inverse residual soybean supply function, indicate that the time trend variable, $T$, was the only variable that caused the multicollinearity problem. To avoid multicollinearity problem, in the final estimation, the time trend variable, $T$, was dropped.
Empirical Estimation and Interpretation

In this section, the two-country partial equilibrium trade model (equation 50-53) is estimated simultaneously by SAS full information maximum likelihood (FIML) method. Estimation results, reported in Table 10, show that for China’s inverse residual demand function (equation 50), four variables, including the Chinese residual demand, \( RD^{US}_{CH} \), the Chinese domestic corn price, \( P^{Corn}_{CH} \), and the prices of soyoil and soymeal in China, \( P^{Oil}_{CH} \) and \( P^{Meal}_{CH} \), are statistically significant at a 1% significant level.

The sign of the estimated coefficient for the Chinese residual demand, \( RD^{US}_{CH} \), is negative as expected, indicating a downward sloping residual demand for U.S. soybeans. By equation (55), the estimated coefficient is also the price flexibility of the Chinese residual demand function for U.S. soybeans, equaling the Adjusted Lerner Index, \( ALI_{US} \), which can be used to measure the market power of U.S. soybean exporters as shown by equation (19). From another perspective, the estimated coefficient also indicates the market margin of U.S. soybean exporters (the difference between the U.S. soybean export price and the sum of the U.S. farm level soybean prices and the transaction costs of U.S. soybean exporters). Results from Table 10 imply that the U.S. soybean exporters’ marketing margin is 4% of the U.S. farm level soybean price.

For the estimated coefficient of the Chinese domestic corn price, results imply that keeping other variables constant, a 1% corn price increase will cause a 27% increase in the Chinese soybean import price from the United States. For the Chinese domestic prices of soyoil and soymeal, they are moving in the same direction with the soybean
import price. The estimated cross price elasticities of the Chinese soybean import price from the U.S. with respect to the soyoil or soymeal prices are 0.44 and 0.30 respectively.

Table 10. Estimation Results of the Two-country Partial Equilibrium Model

| Equation                          | Variable   | Coefficient | Standard Error | t Value | Pr > |t| |
|----------------------------------|------------|-------------|----------------|---------|------|---|
| Chinese Inverse Residual Demand: | Intercept  | -4.2451     | 3.5773         | -1.19   | 0.2405 |
|                                  | $RD_{CH}^D$| -0.0392***  | 0.0141         | -2.78   | 0.0074 |
|                                  | $P_{CH}^{Corn}$| 0.2717***  | 0.0914         | 2.97    | 0.0044 |
|                                  | $INC_{CH}$ | 0.2961      | 0.5201         | 0.57    | 0.5714 |
|                                  | $LDI_{CH}$ | 0.5782      | 0.8977         | 0.64    | 0.5222 |
|                                  | $P_{CH}^{Oil}$ | 0.4430***  | 0.0743         | 5.96    | <.0001 |
|                                  | $P_{CH}^{Meal}$ | 0.3011***  | 0.0794         | 3.79    | 0.0004 |
|                                  | $IMP_{CH}^{SR}$ | -0.0015    | 0.0010         | -1.48   | 0.1448 |
|                                  | $IMP_{CH}^{AR}$ | -0.0005    | 0.0009         | -0.52   | 0.6062 |
|                                  | $BP_{CH}$   | -0.0692     | 0.0435         | -1.59   | 0.1179 |
|                                  | Intercept  | 10.6230***  | 3.9991         | 2.66    | 0.0103 |
|                                  | $RS_{CH}^D$ | 0.1306***  | 0.0405         | 3.23    | 0.0021 |
|                                  | $P_{US}^{Corn}$ | -0.2770    | 0.1442         | -1.92   | 0.0600 |
|                                  | $INC_{US}^{D}$ | -1.1029**  | 0.5496         | -2.01   | 0.0497 |
|                                  | $P_{US}^{Oil}$ | 0.4348***  | 0.0734         | 5.92    | <.0001 |
|                                  | $P_{US}^{Meal}$ | 0.5027***  | 0.1315         | 3.82    | 0.0003 |
|                                  | $XPT_{US}^{EU}$ | -0.0067    | 0.0052         | -1.27   | 0.2082 |
|                                  | $XPT_{US}^{AR}$ | -0.0093    | 0.0370         | -0.25   | 0.8023 |
|                                  | $XPT_{US}^{MX}$ | -0.0848*** | 0.0265         | -3.19   | 0.0023 |
|                                  | $STK_{US}$  | -0.0694***  | 0.0260         | -2.67   | 0.0100 |

Price Relationship:

| Equation                          | Intercept | Coefficient | Standard Error | t Value | Pr > |t| |
|----------------------------------|-----------|-------------|----------------|---------|------|---|
|                                  | Intercept | -5.210      | 0.3634         | -1.43   | 0.1566 |
|                                  | $P_{US}^{IMP}$ | 1.1145***  | 0.0676         | 16.48   | <.0001 |

Note: *** 1% significance level, ** 5% significance level, * 10% significance level.
For the variable Chinese biotech policy, $BP_{CH}$, the sign is negative as expected indicating that the impacts of Chinese biotech policy on U.S. soybean exports to China is negative. However, the variable $BP_{CH}$ is not significant (10% significance level), implying that Chinese biotech policy did not impose significant impacts on U.S. soybean exports to China in the long-run. This result is consistent with the actual observations discussed in Chapter three.

For U.S. inverse residual soybean supply function (equation 51), seven independent variables, including the residual supply quantity, $RS^{CH}_{US}$, the U.S. personal disposable income, $INC_{US}$, the U.S. soyoil prices, $P_{Oil}^{US}$, the U.S. soymeal prices, $P_{Meal}^{US}$, the U.S. soybean exports to Japan, $XPT^{JP}_{US}$, the U.S. soybean exports to Mexico, $XPT^{MX}_{US}$, and the U.S. soybean stocks, $STK_{US}$, are statistically significant at 1% to 5% significance levels respectively as shown in Table 10. The sign of the parameter for the U.S. soybean residual supply for China, $RS^{CH}_{US}$, is positive as expected, indicating an upward sloping U.S. residual soybean supply for China.

By equation (56), the estimated coefficient for the U.S. soybean residual supply quantity, $RS^{CH}_{US}$, is also the price flexibility of the U.S. inverse residual soybean supply function for China, which is also the Adjusted Lerner Index, $ALI_{CH}$ by equation (25), which can be used to measure the market power of Chinese soybean importers. From another perspective, according to the left hand side of equation (25), this estimated coefficient also indicates the marketing margin of Chinese soybean importers (the difference between the Chinese domestic soybean price and the sum of Chinese soybean import price from the U.S. and transaction costs of Chinese soybean importers and import
Results from Table 10 imply that the marketing margin of Chinese soybean importers is 13% of the soybean import price from the U.S. plus tariffs.

Table 11 summarizes the above discussion. The estimated price flexibility of the Chinese inverse residual demand for U.S. soybeans is -0.04, implying that the marketing margin for U.S. soybean exporters (the difference between the U.S. soybean export price and the sum of the U.S. farm level soybean prices and the transaction costs of U.S. soybean exporters) is 4% of the export price. The estimated price flexibility of the U.S. inverse residual soybean supply function for China is 0.13, implying that the marketing margin for Chinese soybean importers is 13% of the soybean import price plus tariffs. Comparing these two coefficients, it can be inferred that the market power of Chinese soybean importers is stronger than that of U.S. soybean exporters.

**Table 11. Summary of the Estimation Results**

| Model                                      | Coefficient for Quantity | Standard Error | T-Value | Pr>|t| |
|--------------------------------------------|--------------------------|----------------|---------|-----|
| Chinese Inverse Residual Demand: \( P_{US}^{IMP} = P(Q_{CH}^{IMP}, ...) \) | -0.04***                  | 0.0141         | -2.78   | 0.0074 |
| U.S. Inverse Residual Supply: \( P_{US}^{XPT} = P(Q_{US}^{XPT}, ...) \) | 0.13***                   | 0.0405         | 3.23    | 0.0021 |

Note: *** 1% significance level, ** 5% significance level, * 10% significance level.
CHAPTER EIGHT

COMPETITIVE ANALYSIS OF CHINA’S SOYBEAN IMPORT MARKET

Results of Chapter seven show that in the Chinese soybean import market Chinese soybean importers have stronger market power than U.S. soybean exporters. In addition, it is assumed that Chinese soybean importers also have stronger market power than soybean exporters from Brazil and Argentina. Based on the above results and assumption, a competitive analysis of the Chinese soybean import market is conducted by examining both annual and monthly data of Chinese soybean imports from these three soybean exporting countries. In addition, after examining the competitive structure of these three soybean exporters in the Chinese soybean import market, competitiveness of the U.S., Brazil, and Argentina in the Chinese soybean import market is compared by analyzing their soybean exports costs.

The U.S., Brazil, and Argentina in the Chinese Soybean Import Market

As reviewed in Chapter two, China is the number one soybean importer and the U.S., Brazil, and Argentina are the top three soybean exporters in the world. Figure 25 shows that soybean surpluses (defined as the difference between the domestic supply and the domestic consumption in soybean exporting countries) in the U.S., Brazil, and Argentina increased annually in recent years. In 2005, soybean surpluses in the U.S., Brazil, and Argentina reached 33, 25, and 10 million metric tons, respectively (USDA-FAS, 2006b). To avoid high accumulation of soybean stockpiles, export markets are crucial for the soybean industries in the U.S., Brazil, and Argentina.
Soybean Surpluses in the U.S., Brazil, and Argentina

**Figure 25. Soybean Surplus in Main Soybean Exporting Countries**

Source: USDA-FAS, PS&D data, 2006b.

Soybean Shortages in China, the EU, Japan, and Mexico

**Figure 26. Soybean Shortage in Main Soybean Importing Countries**

Source: USDA-FAS, PS&D data, 2006b.
Figure 26 shows the trends of soybean shortages (defined as the difference between the domestic consumption and the domestic production in the soybean importing countries) for the top soybean importers in the world, including China, the European Union, Japan, and Mexico. Soybean shortage in Japan was quite stable in the past, and soybean shortage in the EU and Mexico did not increase much in the past decade. By these trends, it can not be expected that the EU, Japan, and Mexico will increase their soybean imports much in the future. However, for China, its soybean shortage increased dramatically in recent years, from almost null in 1991 to 27 million metric tons in 2005.

Combining the above trends of soybean exporters and soybean importers, it is reasonable to state that China is and will continue to be the most important market for the U.S., Brazil, and Argentina’s soybean surpluses. Results from Chapter seven indicate that Chinese soybean importers had stronger market power over U.S. soybean importers. Three large soybean suppliers facing one large soybean buyer with a rapid growth potential may support the assumption that Chinese soybean importers may have stronger market power than soybean exporters from Brazil and Argentina.

Because China is the most important market for the U.S., Brazil, and Argentina, these three soybean exporters compete with each other in the Chinese soybean import market to expand their soybean market shares. From a soybean suppliers’ perspective, the competitive relationship among the U.S., Brazil, and Argentina in the Chinese soybean import market will be examined in the following section. To simplify the problem, Brazil and Argentina are considered as a group, the South America (SA) soybean supplier. As shown in figure 27, the U.S. and South America (Brazil and Argentina) are competing in the leading soybean import market, China. However, the
The question is “what is the relationship between the U.S. and South America in the Chinese soybean import market?”

Figure 27. Chinese Soybean Import Market

* Source: MapQuest, Inc. (Mapquest.com).

Are the U.S. and South America Substitutive Soybean Suppliers for China?

Figure 28 shows that Chinese annual soybean imports from South America were slightly lower than that from the U.S. before 2001 and in 2004. From 2001 to 2003 and
2005, Chinese annual soybean imports from South America surpassed the United States. In 2005, China imported 15.35 million metric tons of soybeans from SA with Brazil 7.95 million metric tons and Argentina 7.4 million metric tons. In contrast, China imported 11 million metric tons of soybeans from the United States. U.S. soybean exports to China were higher than the soybean exports from either Brazil or Argentina to China, but lower than the sum of Brazil’s and Argentina’s soybean exports to China.

Figure 28. Chinese Soybean Imports from the U.S. and South America
Source: The Chinese Minister of Agriculture, 2006

Since soybeans produced in both the U.S. and South America contain biotech varieties, we can assume that soybeans exported to China from the U.S. and SA were homogeneous. If the U.S. chose to set higher export prices, China could reduce their imports from the U.S. and increase their imports from South America, provided that soybean stocks in the U.S. were enough to satisfy China’s soybean demand, vice versa. By examining the soybean export prices from the U.S. and South America, it can be
found that the soybean export prices from the U.S., Brazil, and Argentina to China were similar as shown in figure 29. Observations indicate that the U.S. and SA chose to set their soybean export prices at similar levels, and Chinese soybean importers decided how much to buy soybeans from each soybean supplier. Next step is to investigate the soybean stocks in the U.S. and SA to see whether their soybean stocks can satisfy China’s soybean demand, which is a necessary condition for the U.S. and SA to be substitute suppliers to supply soybeans to China.

![China's Soybean Import Prices from the U.S., Brazil, and Argentina](image)

**Figure 29. Chinese Soybean Import Prices from the U.S., Brazil, and Argentina**

*These export prices are derived CIF prices, divided export value by export quantity. Those observations that export quantity was zero were deleted; Pusch is the soybean export price from the U.S. to China, Pbrch is the soybean export price from Brazil to China, and Parch is the soybean export price from Argentina to China.

Figure 30 shows China’s soybean imports from the U.S. and soybean stocks in SA. If there is a production shock in the U.S. or U.S. soybean exporters raise their soybean export prices, soybean stocks in SA are more than enough to satisfy China’s soybean
demand. From this perspective, SA can be a substitute supplier for the U.S. to supply soybeans to China. In contrast, Figure 31 shows China’s soybean imports from SA and soybean stocks in the United States. If there is a production shock in SA or if SA soybean exporters raise their soybean export prices, soybean stocks in the U.S. are NOT enough to satisfy China’s soybean demand from 2001 to 2004. Even in 2005, U.S. soybean stocks were just able to satisfy China’s demand. From this perspective, the U.S. cannot serve as a complete substitute supplier for SA to supply soybeans to China. But the U.S. could be a partial substitute for SA to supply soybeans to China.

![Graph showing China's soybean imports from the U.S. and soybean stocks in SA from 1995 to 2005.](image)

**Figure 30. China’s Soybean Imports from the U.S. and Soybean Stocks in SA**

Source: USDA-FAS, 2006a; the Chinese Minister of Agriculture, 2006.
The U.S. and South America Are Seasonal Complementary Soybean Suppliers for China

Since the U.S. is located in the northern hemisphere and South America is located in the southern hemisphere, they have opposing growing seasons, i.e., different production time periods to supply soybeans to markets. Similar to China, the harvest season for U.S. soybeans is in October and November, and for South America, March and April. Figure 32 plots the U.S. monthly soybean stocks and Figure 33 shows the monthly soybean stock levels in Brazil (Argentina data is not available). Figure 32 indicates that, generally, U.S. soybean stocks reach the highest level in November. Then due to consumption and exports, U.S. soybean stocks decrease to their lowest levels in August and September, with some years in October. For Brazil (Figure 33), the soybean stocks normally reach their highest level in April. Then due to consumption and exports, Brazilian soybean stocks decline gradually, and reach their lowest levels in January and February.
Figure 32. U.S. Soybean Stocks

Source: USDA-ERS, 2005b; 2005c.

Figure 33. Brazilian Soybean Stocks

Because of the difference in soybean growing seasons for the U.S. and South America, their soybean export behaviors are different. Figure 34 depicts the U.S. and South America’s average monthly soybean exports to China from 1999 to 2004. Figure 34 clearly shows that soybean trade in the Chinese import market can be divided into two periods. The first period is the South American period (period I), which includes June, July, August, September, and October. In period I, SA exports just harvested soybeans to China, without or with less storage costs, and the U.S. exports stocked soybeans to China with additional storage costs. South America has the seasonal advantage and results in a dominant position in the Chinese soybean import market and the U.S. is in a disadvantageous position because of the additional storage costs.

![Figure 34. Average Monthly Soybean Exports from the U.S. and South America (Brazil and Argentina) to China (1999-2004)](image)

The second period is the U.S. period (period II), which includes November, December, January, February, March, April, and May. In this period, the U.S. has just harvested their soybeans and becomes the main soybean supplier for China, and South America supplies only a small amount of soybeans for China from their soybean stocks during period II. In period II the U.S. exports just harvested soybeans to China without or with little storage costs and SA exports stocked soybeans with additional storage costs. Therefore, the U.S. has the seasonal advantage in this period, resulting in a dominant position in the Chinese soybean import market and SA is in a disadvantageous position due to the additional storage costs. The above analysis implies that South America and the U.S. are seasonal complementary soybean suppliers for China, with South America dominating period I and the U.S. dominating period II.

From the importers’ side, Chinese soybean importers may have stronger market power relative to soybean exporters from both the U.S. and SA, and they will exercise their monopsony power to maximize their soybean import profits. Strategically, to reduce the risk of price increases, Chinese soybean importers will not rely on only one soybean supplying country. Chinese soybean importers will work with different soybean supplying countries to diversify their supply risk. Taking this seasonal factor into consideration, we hypothesize that Chinese soybean importers will import soybeans from SA in period I, and from the U.S. in period II. In that case, because of the market power of Chinese soybean importers and this seasonal difference, the U.S. and SA actually become seasonal complementary soybean suppliers for China, with SA dominating period I and the U.S. dominating period II.
Competitiveness Comparison among the U.S., Brazil, and Argentina in the Chinese Soybean Import Market

Competitiveness of soybean industries of the U.S., Brazil, and Argentina in the Chinese soybean import market can be evaluated by comparing their export costs. Schnepf, et al. (2001) compared soybean export costs of the U.S., Brazil, and Argentina. Schnepf, et al. divided export costs into three categories, including production costs, internal marketing and transportation costs, and international transportation costs. Production costs were further separated into variable costs and fixed costs. They used 1998/99 data and compared export costs of the heartland region from the U.S., the State of Parana and Moto Grosso from Brazil, and the northern Buenos Aires/southern Santa Fe area from Argentina. Table 12 shows the difference of export costs for the U.S., Brazil, and Argentina.

From Table 12, we can draw the following conclusions

1. The soybean production costs in Brazil were the lowest among the three countries, and soybean production costs in the U.S. were the highest with Argentina lying between them and close to Brazil;

2. The internal transport and marketing costs in the U.S. were the lowest among the three countries, and the internal transport and marketing costs in the Brazil were the highest with Argentina lying between them and close to Brazil;

3. The freight costs from the U.S. to China were the lower relative to the freight costs from Brazil and Argentina to China;
Table 12. Soybean Export Costs of the U.S., Brazil, and Argentina

<table>
<thead>
<tr>
<th>Cost Item*</th>
<th>U.S.</th>
<th>Brazil</th>
<th>Argentina</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Heartland</td>
<td>Parana</td>
<td>Mato Grosso</td>
</tr>
<tr>
<td>Variable Costs</td>
<td>$/bu.</td>
<td>$/bu.</td>
<td>% of U.S. Costs</td>
</tr>
<tr>
<td>Fixed Costs</td>
<td>$/bu.</td>
<td>$/bu.</td>
<td>% of U.S. Costs</td>
</tr>
<tr>
<td><strong>Total Production Costs</strong></td>
<td>5.11</td>
<td>4.16</td>
<td>81%</td>
</tr>
<tr>
<td>Internal Transport &amp; Marketing Costs</td>
<td>0.43</td>
<td>0.85</td>
<td>--</td>
</tr>
<tr>
<td><strong>Cost at Border</strong></td>
<td>5.54</td>
<td>5.01</td>
<td>90%</td>
</tr>
<tr>
<td>Freight Costs to China**</td>
<td>0.75</td>
<td>0.81</td>
<td>--</td>
</tr>
<tr>
<td>Export Tax***</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td><strong>Cost at Main China Ports</strong></td>
<td>6.29</td>
<td>5.82</td>
<td>93%</td>
</tr>
</tbody>
</table>

* Data for production costs and internal transport and marketing costs are 1989/99 data from Schnepf, et al. (2001).

** The freight costs to China are 2005 data from USDA-AMS, “Grain Transportation Reports”, February 2005.

*** Argentina imposed a 23.5% export tax and surcharge on soybean exports from 2001. (See Chapter three—Soybean Policies in Argentina).

4. Export taxes and surcharges increased the soybean export costs for Argentina;

5. In aggregate, the total soybean export costs for Brazil were the lowest and the export costs for Argentina were the highest with the U.S. lying between them. However, if the Argentinean government eliminates export taxes on soybeans, then the total soybean export costs for Argentina will be $5.54/bushel and becomes the lowest.
Therefore, Argentina still has a great potential to become the most competitive soybean supplier in the Chinese soybean import market.

**Summary**

Based on the empirical results from Chapter seven, this chapter examined the competitive structure of the Chinese soybean import market. As the number one soybean importer in the world, Chinese soybean importers have stronger market power over soybean exporters from the U.S., Brazil, and Argentina. The top three soybean suppliers for China—the U.S., Brazil, and Argentina—compete with each other in the Chinese soybean import market.

From China’s side, Chinese soybean importers can exercise their monopsony power to maximize their import profits. Strategically, Chinese soybean importers will not rely on a single soybean supplier. To reduce the risk of a price increase, Chinese soybean importers will establish good relationships with different soybean supplying countries to diversify their supply risk. Taking the seasonal factor into consideration, Chinese soybean importers import most of their soybeans from South America in period I, and the U.S. in period II. Due to Chinese soybean importers strategic choice and the seasonal difference, the U.S. and South America (Brazil and Argentina) actually become seasonal complementary soybean suppliers for China, with South America dominating period I and the U.S. dominating period II.

However, from their export costs’ perspective, currently, Brazilian soybean export costs were the lowest and Argentinean soybean export costs were the highest with the
U.S. in the middle. However, if the Argentinean government can eliminate export taxes on soybeans, the soybean export costs in Argentina could be the lowest.
CHAPTER NINE
CONCLUSIONS

Summary and Conclusions

China, as the number one soybean importer with 1.3 billion people and rapid economic growth, becomes a potential enormous market for soybeans. Compared to other main soybean importers in the world, China attracts more attention from the U.S., Brazil, and Argentina, the leading global soybean suppliers. The U.S. leads the world in soybean production, consumption, and exports. U.S. soybean policy, including government loan programs and direct and counter-cyclical government payment programs, played a very important role in supporting the U.S. soybean industry and keeping the U.S.’ leading position in the world. In the last decade, because of economic reform in the South America (Brazil and Argentina), soybean industries in Brazil and Argentina developed rapidly. South America became the main soybean supplier and a strong competitor for the U.S. in the world soybean market.

With the continuous increase in excess soybean supplies in the U.S., Brazil, and Argentina, China becomes the primary market for their soybean surplus. As a result, these three soybean exporters—the U.S., Brazil, and Argentina—are competing in the Chinese soybean import market. Given the above facts, we can hypothesize that the Chinese soybean market can be characterized either by monopsony, whereby Chinese soybean importers have stronger market power relative to soybean exporters in the U.S, Brazil, and Argentina; or oligopoly, whereby soybean exporters from the U.S., Brazil, and Argentina have relatively stronger market power. This research, based on the inverse
residual demand and inverse residual supply model, developed a two-country partial
equilibrium trade model to test who has stronger market power in the Chinese soybean
import market.

Past research to test market power used either the inverse residual demand model
or the inverse residual supply model (Carter, et al., 1999; Goldberg and Knetter, 1999;
Poosiripinyo and Reed, 2005), which were defined as unrestricted models, because they
did not include an equilibrium condition. Without an equilibrium condition, estimation
results from the unrestricted model may not be reliable. This research developed a
restricted model, a two-country partial equilibrium trade model combining the inverse
residual demand and the inverse residual supply model together and incorporated the
equilibrium condition in the model as a system, to test market power of the Chinese
soybean import market.

Because data for Brazil and Argentina were difficult to obtain, this research
applied the two-country partial equilibrium model to U.S.-China soybean trade. By
comparing the results from the restricted model and unrestricted model, this research
found that results from the restricted model were more reasonable and consistent with
actual observations. The estimated price flexibilities or the Adjusted Lerner Indexes from
the restricted model also suggest that Chinese soybean importers have stronger market
power relative to U.S. soybean exporters. The marketing margin for U.S. soybean
exporters (the difference between the U.S. soybean export price and the sum of the U.S.
farm level soybean prices and the transaction costs of U.S. soybean exporters) was
estimated at 4% of the export price. In contrast, the marketing margin for Chinese
soybean importers (the difference between China domestic soybean price (in U.S. dollars)
and the sum of soybean import price from the U.S. and import tariffs plus the transaction costs of China’s soybean imports from the U.S.) is 13% of the soybean import price plus tariff.

In regards to Chinese biotech policies, the estimated result from the restricted model implies that Chinese biotech policies have not imposed significant impacts on U.S. soybean exports to China.

On the basis of these empirical results, this research further analyzed the competitive structure of the Chinese soybean import market. By examining monthly data, South America and the U.S. look like seasonal complementary soybean suppliers to China, with South America dominating period I (June, July, August, September, and October) and the U.S. dominating period II (November, December, January, February, March, April, and May). Possible explanation is that Chinese soybean importers exercise their monopsony power and choose to diversify their soybean suppliers, reducing price risk of depending on only one soybean supplier. Chinese soybean importers’ strategic choice and the seasonal difference make the U.S. and South America seasonal complementary soybean suppliers for China.

Comparing soybean export costs of the three countries, Brazil has the most advantage in soybean production costs, followed by Argentina and the U.S.; the U.S. has the most advantage in its internal transport and marketing costs, followed by Argentina and Brazil; and the U.S. also has the advantage in its international transportation costs compared to Brazil and Argentina. One disadvantage for the Argentinean soybean industry is its export tax and surcharges imposed by their government, which reduces its
competitiveness in the international market. In aggregate, the total soybean export costs for Brazil were the lowest and the export costs for Argentina were the highest with the U.S. lying between them. However, if the Argentinean government eliminates its export taxes on soybeans, then the total soybean export costs for Argentina will be the lowest. Therefore, Argentina still has great potential to become the most competitive soybean supplier for China.

**Policy Implications**

In terms of policy implications for the U.S. soybean industry, facing strong competition from South America, it is difficult to keep the U.S. in its lead position in the world. In addition, we cannot expect that U.S. market share in the Chinese soybean import market can be further expanded. If U.S. soybean production continues to grow, other sources of soybean consumption, like industrial usage for fuel transformation, will be required for maintaining stable farm incomes for U.S. soybean farmers. The U.S. soybean export advantage is its relatively low marketing and transportation costs both domestically and internationally. With the development of infrastructure in Brazil and Argentina, this U.S. advantage will become less and less. Therefore, if the U.S. soybean industry wants to keep their current position in the Chinese soybean import market, some governmental policy supports may be necessary.

**Future Research**

When data for Brazil and Argentina are available, the two-country partial equilibrium models for Brazil-China and Argentina-China can be empirically tested. To precisely examine the competitiveness of the soybean industries of the U.S., Brazil, and
Argentina in the Chinese soybean import market, costs models, which can reflect storage costs and production costs as well as other transportation costs, can be developed and applied. In addition, the two-country partial equilibrium trade model also can be adjusted and applied to other bulk commodity trade in the international market.
REFERENCES:


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“Dissertation Enhancement Award” ($3000), University of Kentucky, 2004
“Student Travel Award ($400) for Professional Meeting”, University of Kentucky, 2004.

“Student Travel Award ($400) for Professional Meeting”, University of Kentucky, 2003.

“Student Travel Award ($400) for Professional Meeting”, University of Kentucky, 2002.

Selected Publications


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10/03-Present: American Agricultural Economics Association.

01/03-Present: Southern Agricultural Economics Association.

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