



AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search

<http://ageconsearch.umn.edu>

aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

**The Impact of Brazil and Argentina's Currency Devaluation
on U.S. Soybean Trade**

**Jose Andino
Kranti Mulik
Won W. Koo**



**Center for Agricultural Policy and Trade Studies
Department of Agribusiness and Applied Economics
North Dakota State University
Fargo, North Dakota**

ACKNOWLEDGMENTS

The authors extend appreciation to Mr. Bruce Dahl, Mr. Richard D. Taylor, Dr. Jungho Baek, and Dr. George Flaskerud for their constructive comments and suggestions. Special thanks go to Ms. Beth Ambrosio, who helped to prepare the manuscript.

The research was conducted under the U.S. agricultural policy and trade research program funded by the U.S. Department of Homeland Security/U.S. Customs and Border Protection Service (Grant No. TC-03-003G, ND1301).

We would be happy to provide a single copy of this publication free of charge. You can address your inquiry to: Beth Ambrosio, Center for Agricultural Policy and Trade Studies, Department of Agribusiness & Applied Economics, North Dakota State University, P.O. Box 5636, Fargo, ND, 58105-5636, Ph. 701-231-7334, Fax 701-231-7400, e-mail beth.ambrosio@ndsu.nodak.edu. This publication is also available electronically at this web site: <http://agecon.lib.umn.edu/>.

NDSU is an equal opportunity institution.

NOTICE:

The analyses and views reported in this paper are those of the author(s). They are not necessarily endorsed by the Department of Agribusiness and Applied Economics or by North Dakota State University.

North Dakota State University is committed to the policy that all persons shall have equal access to its programs, and employment without regard to race, color, creed, religion, national origin, sex, age, marital status, disability, public assistance status, veteran status, or sexual orientation.

Information on other titles in this series may be obtained from: Department of Agribusiness and Applied Economics, North Dakota State University, P.O. Box 5636, Fargo, ND 58105. Telephone: 701-231-7441, Fax: 701-231-7400, or e-mail: cjensen@ndsuent.nodak.edu.

Copyright © 2005 by Jose Andino, Kranti Mulik, and Won W. Koo. All rights reserved. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided that this copyright notice appears on all such copies.

TABLE OF CONTENTS

List of Tables	ii
List of Figures	ii
Abstract	iii
Highlights.....	iv
Introduction.....	1
Literature Review.....	2
Global Trends in Soybean Production and Trade	2
Production	2
Trade	3
Issues in U.S. Soybean Trade	7
Genetically Modified (GM) Soybeans.....	7
Exchange Rates and Prices	7
Model	8
Estimation Procedure	10
Data and Sources.....	11
Stationary Properties of the Variables	11
Empirical Results	13
Summary and Conclusions	14
References.....	16

LIST OF TABLES

<u>No.</u>		<u>Page</u>
1	Descriptive Statistics for Imports of Soybeans from the United States and Brazil by Major Importing Countries (1994-2003)	3
2	Nominal Exchange Rates Between the United States and Brazilian “Real” and Argentinean “Peso”	7
3	Results of Panel Unit Root Tests	12
4	Results for Import Demand of Soybeans from the United States and Argentina and Brazil by Major Importing Countries.....	13

LIST OF FIGURES

<u>No.</u>		<u>Page</u>
1	Market Share of U.S. Soybean Exports in Major Importing Countries (1994-2003).....	4
2	Exports of Soybeans from Brazil to Major Importing Countries (1994-2003)	5
3	Exports of Soybeans from Argentina to Major Importing Countries (1994-2003)	6
4	Nominal Soybean Export Prices for Argentina, Brazil, and the United States (1993-2004)	8

Abstract

We analyzed the effects of Brazil and Argentina's currency devaluation on the U.S. soybean import demand in major importing countries. Results indicate that nominal exchange rates between the United States and importers affect the U.S. soybean export market. Additionally, we found evidence that currency depreciations have favored soybean exports from Argentina and Brazil at the cost of reduced exports from the United States. Increased world soybean demand has promoted export sales from major producers, affecting export prices. However, adoption of GM soybeans in the United States has been a determinant in decreased U.S. soybean exports.

Keywords: soybeans, exchange rates, third country effect, EC3SLS.

Highlights

The soybean export market is a significant contributor to U.S. agricultural export earnings. However, the U.S. share in major importing countries is being displaced by exports from several competitors, particularly Brazil and Argentina. These countries have benefited from reduced costs in production, marketing, and domestic transportation as a result of political reforms and infrastructure development. Furthermore, currency devaluation in Argentina and Brazil may also be an important factor underlying the declining role of U.S. soybeans in world markets. The main objective of this paper is to analyze the effect of Brazilian and Argentinean currency devaluation on imports of U.S. soybeans by major importing countries: China, Germany, Indonesia, Japan, Mexico, Netherlands, Korea, Spain, and Thailand. Two import demand equations were estimated, one for the United States and another for the import demand from the rest of the world, mainly Argentina and Brazil. The equations were estimated simultaneously using an error component three-stage least squares (EC3SLS) procedure.

Results indicate that soybean exports from the United States have been affected by changes in exchange rates. A stronger dollar relative to an importer's currency decreases U.S. soybean sales. Also, our findings suggest that depreciation (appreciation) of Brazilian and Argentinean currencies decreases (increases) soybean exports from the United States. Because of the similarity among soybean export prices of the United States, Brazil, and Argentina, currency devaluations in Argentina and Brazil could have created an advantage over the United States in exporting soybeans.

It is also expected that increases in total soybean imports by importing countries would increase the volume of soybean sales from all exporting countries. However, while the United States and other exporters are still increasing export volumes, they are not growing the same proportion as Argentina and Brazil's exports. Finally, our results indicate that increased adoption of GM soybeans in the United States has been a determinant in decreased U.S. soybean exports.

The Impact of Brazil and Argentina's Currency Devaluation on U.S. Soybean Trade

Jose Andino, Kranti Mulik, and Won W. Koo*

INTRODUCTION

The soybean export market is a significant contributor to U.S. agricultural export income. In 2004, exports of soybeans and soybean products comprised 78 percent of the total U.S. exports of oilseeds, meals, and vegetable oils, with earnings totaling about eight billion dollars. Although the volume of U.S. soybean exports has increased, the U.S. share in major importing countries is being displaced by exports from several competitors, particularly Brazil and Argentina. These countries have benefited from declining production, marketing, and transportation costs as a result of political reforms and infrastructure development. Furthermore, currency devaluation in Argentina and Brazil may also be an important factor underlying the declining role of U.S. soybeans in world markets. The decision by Brazil to devalue the real in 1997 and the subsequent devaluation of the peso by Argentina in 2002 have caused a major uproar among U.S. stakeholders. Farmers and exporters have claimed that because Brazil and Argentina decreased the value of their currencies relative to the value of the U.S. dollar, soybeans from the United States are more expensive than their competitors' products. As U.S. farmers are losing their competitive edge in the world soybean market, it becomes necessary to take actions to sustain U.S. exports.

Several works have studied the importance of exchange rates on agricultural markets. Most have concluded that exchange rate fluctuations affect the actual price paid for products; therefore, importers adjust demand among alternative sources of supply. The majority of work in this area has concentrated on bilateral interactions between importers and exporters; less attention has been given to the effect of competitors' exchange rate changes on exports by a specific country.

The objective of our study is to analyze the impact of the Brazilian and Argentinean currency devaluations on U.S. soybean purchases by major importing countries: China, Germany, Indonesia, Japan, Mexico, the Netherlands, Korea, Spain, and Thailand. Previous studies have not estimated competitors' exchange rate effects on the performance of U.S. soybean exports. Quantification of this relationship will provide valuable insight for designing strategies for U.S. producers and exporters to compete more effectively in order to retain world market shares.

The paper is organized in the following way: we begin by presenting an overview of relevant research on exchange rates and agricultural products. Global trends for soybean production and trade are discussed in the next section, followed by a brief overview of issues in the U.S. soybean trade. The subsequent section describes the model, estimation techniques, and data sources. Empirical results are then discussed, and the final section consists of summary and conclusions.

* Research Assistant Professors, and Professor and Director, respectively, in the Center for Agricultural Policy and Trade Studies, North Dakota State University, Fargo.

LITERATURE REVIEW

Schuh (1974 and 1976) instigated the study of exchange rate changes and their effect on the performance of agricultural trade. From his work, a line of research was developed to evaluate the effect of nominal and real exchange rates on domestic and foreign markets for agricultural commodities (Chambers and Just, 1979 and 1981; Greenshields, 1974; Johnson, Grennes, and Thursby, 1977; Batten and Belongia, 1986). The majority of researchers concluded that prices and exports of agricultural commodities are sensitive to changes in exchange rates. Recent research has focused on the effect of exchange rate uncertainty on trade of agricultural commodities (Anderson and Garcia, 1989; Batten and Belongia, 1986; Haley and Krissoff, 1987; Bessler and Babula, 1987; Pick, 1990; Maskus, 1986; Klein, 1990; Langley, et al., 2000). The majority of evidence indicates that exchange rate uncertainty depresses trade of agricultural products.

Most of the works in the exchange rate literature have concentrated on bilateral interactions between importers and exporters, but Cushman (1986) and Jin, Cho, and Koo (2004) included a third-country effect to evaluate competition among alternative importers and exporters, respectively. These researchers argue to include currency information on competing countries is that omission of third-country effects could bias the analysis of bilateral trade flows (Cushman, 1986). Both investigations found evidence of third-country risk effects; however, Jin, Cho, and Koo (2004) concluded that a competitor's exchange rates are not relevant in their case, which focused on determining U.S. wheat market shares in Asian countries.

For soybeans, exchange rate changes have been found to exercise a significant impact on trade (Anderson and Garcia, 1989; Chambers and Just, 1981; Sarwar and Anderson, 1990). For instance, Anderson and Garcia (1989) concluded that short-term variations in nominal bilateral exchange rates reduce the volume of U.S. soybeans traded with major importers, and that the effect varies across countries. In contrast, Greenshields (1974) reported that exchange rate changes have little effect on soybean exports from the United States.

GLOBAL TRENDS IN SOYBEAN PRODUCTION AND TRADE

Production

The United States, Brazil, and Argentina are the world's leading producers and exporters of soybeans, responsible for 80 percent of the world production. The United States produced 86 million metric tons in 2004, followed by Brazil and Argentina with 53 and 39 million metric tons, respectively (USDA, ERS PSD Tables, 2004). Production in Brazil and Argentina has increased substantially in recent years, and production in Paraguay and Uruguay has also grown significantly to 3.8 million and 0.5 million metric tons, respectively, in 2004. Projections for 2005 suggest production will increase by 25 percent for Brazil, while production in the United States is expected to decrease by 8 percent. Production in Argentina is expected to remain at the same level as last year (USDA, FAS PSD Tables, 2004). During 1998-2002, the average combined soybean production of Brazil, Argentina, and Paraguay was approximately 71 million metric tons, which is about 95 percent of the U.S. total soybean production. In 2004, the combined production of the three countries was 96 million metric tons, 12 percent greater than U.S. production (USDA, FAS PSD Tables, 2004).

According to Schnepf, Dohlman, and Bolling (2001), economic and political reforms, infrastructure development, and enhanced use of agricultural inputs have promoted a good environment for increased agricultural production in Argentina and Brazil. As a result, Dohlman, Schenepf, and Bolling (2001) concluded that Brazil and Argentina have the ability to market soybeans to Rotterdam at a lower cost than U.S. soybeans produced in the Corn Belt. Due to significant increases in yields and cultivated area, the potential for future production growth in Brazil is still substantial. However, market share gains would depend on exchange rate changes, economic stability, further infrastructure improvements, and policy reforms (Schnepf, Dohlman, and Bolling, 2001). For Argentina, future production may be constrained by limited land for agricultural production (Dohlman, Schenepf, and Bolling, 2001).

Trade

The soybean export market can be divided into three product categories: beans, oil, and meal. While the United States dominates the bean export market, Argentina is the principal exporter of meal and oil, followed by Brazil and the United States. During the period 1996-2004, U.S. exports of soybean meal and oil averaged 6.7 million and 0.9 million metric tons, respectively. For 2005, U.S. exports are projected to decrease 6 percent for meal and remain the same for oil (USDA, FAS PSD Tables, 2004).

China is the largest soybean importer in the world, followed by the European Union (EU) and Japan. Despite being a leading producer of soybeans, China contributes less than 0.5 percent to world soybean exports. By contrast, increased imports by China are substantially influencing world demand and therefore world soybean prices. In 2004, China imported about 22.8 million metric tons. During the same year, the EU-25 and Japan imported 15 million and 5 million metric tons, respectively (USDA, ERS PSD Tables). Within the EU, the major importing countries are Germany, Spain, and the Netherlands, while major importers of soybeans from Asia include Japan, Korea, Thailand, and Indonesia. In 2002, Asian countries accounted for more than 55 percent of total world soybean imports. Table 1 presents the mean and standard deviation for soybean imports from the United States and Brazil by major importing countries. On average, during the period 1994-2003, Japan was the major importer of soybeans from the United States, followed by Mexico and China. For Brazil, major soybean exports have been sold to China, followed by the Netherlands, Germany, and Spain.

Table 1. Descriptive Statistics for Imports of Soybeans from the United States and Brazil by Major Importing Countries (1994-2003)

Country	United States		Brazil	
	Mean	St. Dev.	Mean	St. Dev.
	------(1,000 Metric Tons)-----			
China	3,165.1	2,737.1	1,995.6	2,168.1
Germany	1,743.1	273.9	1,320.2	593.6
Indonesia	774.2	351.5	26.5	20.9
Japan	3,797.2	162.4	634.7	181.6
Korea	1,267.5	114.0	137.2	69.4
Mexico	3,474.3	812.7	94.8	100.1
Netherlands	1,899.7	833.5	1,671.3	1,049.2
Spain	1,420.1	209.2	1,024.3	427.4
Thailand	559.7	182.5	119.3	86.6

Even though the United States still dominates the Chinese soybean market, its prominence in other countries has changed. Figure 1 presents the market shares for the United States in major importing markets for the period 1994-2003. Although the volume of U.S. soybean exports to some of these countries has been increasing, there is a declining trend of market shares in all the selected countries except Indonesia and Mexico. This situation results in an overall reduction in world market share for U.S. soybeans.

Figures 2 and 3 present the volume of exports from Brazil and Argentina to major importing countries. The figures show that Brazil's soybean exports to China, Germany, Japan, the Netherlands, Korea, and Spain have substantially increased, while for Argentina, soybean exports to China and Thailand have also increased.

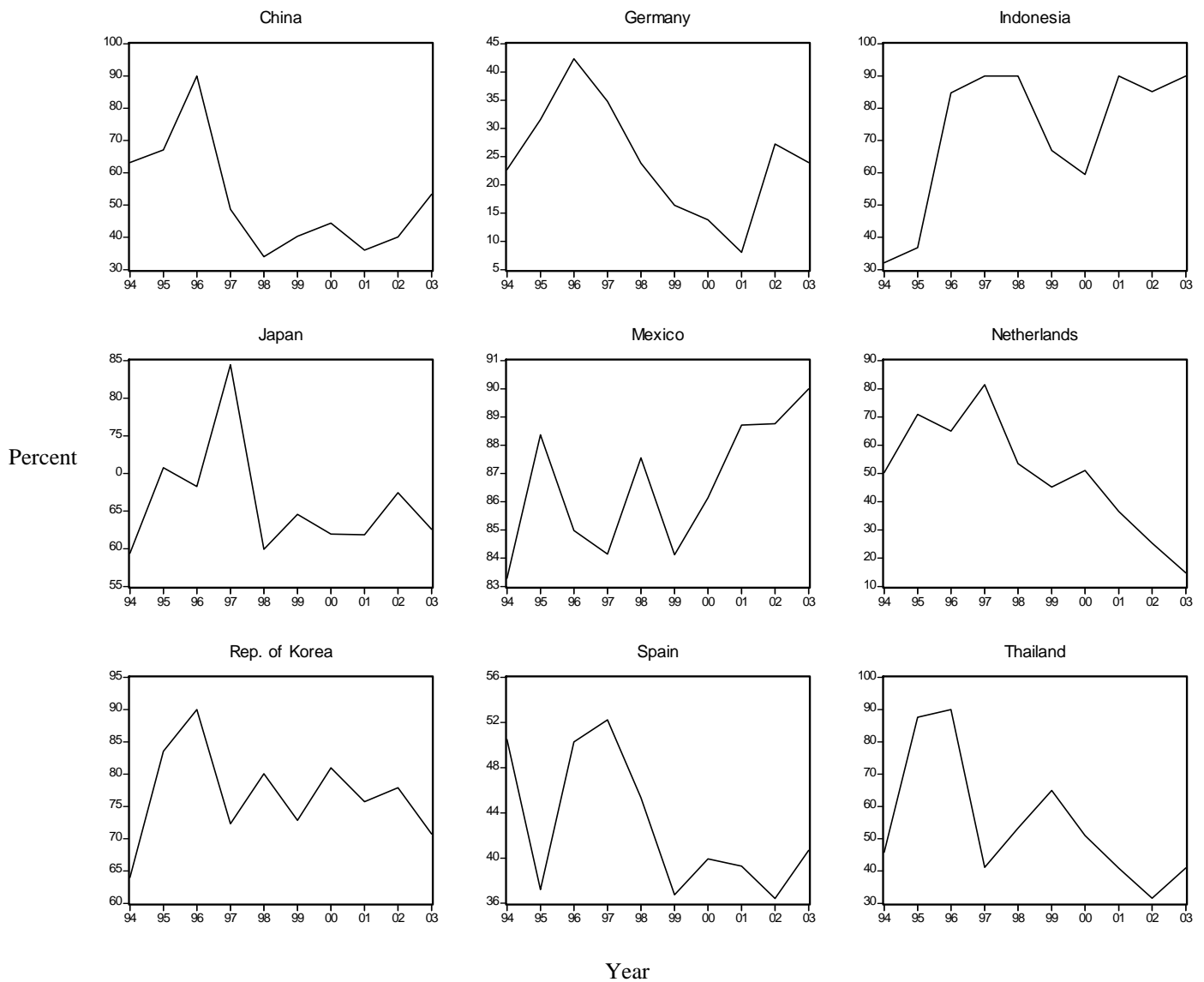


Figure 1. Market Share of U.S. Soybean Exports in Major Importing Countries (1994-2003)

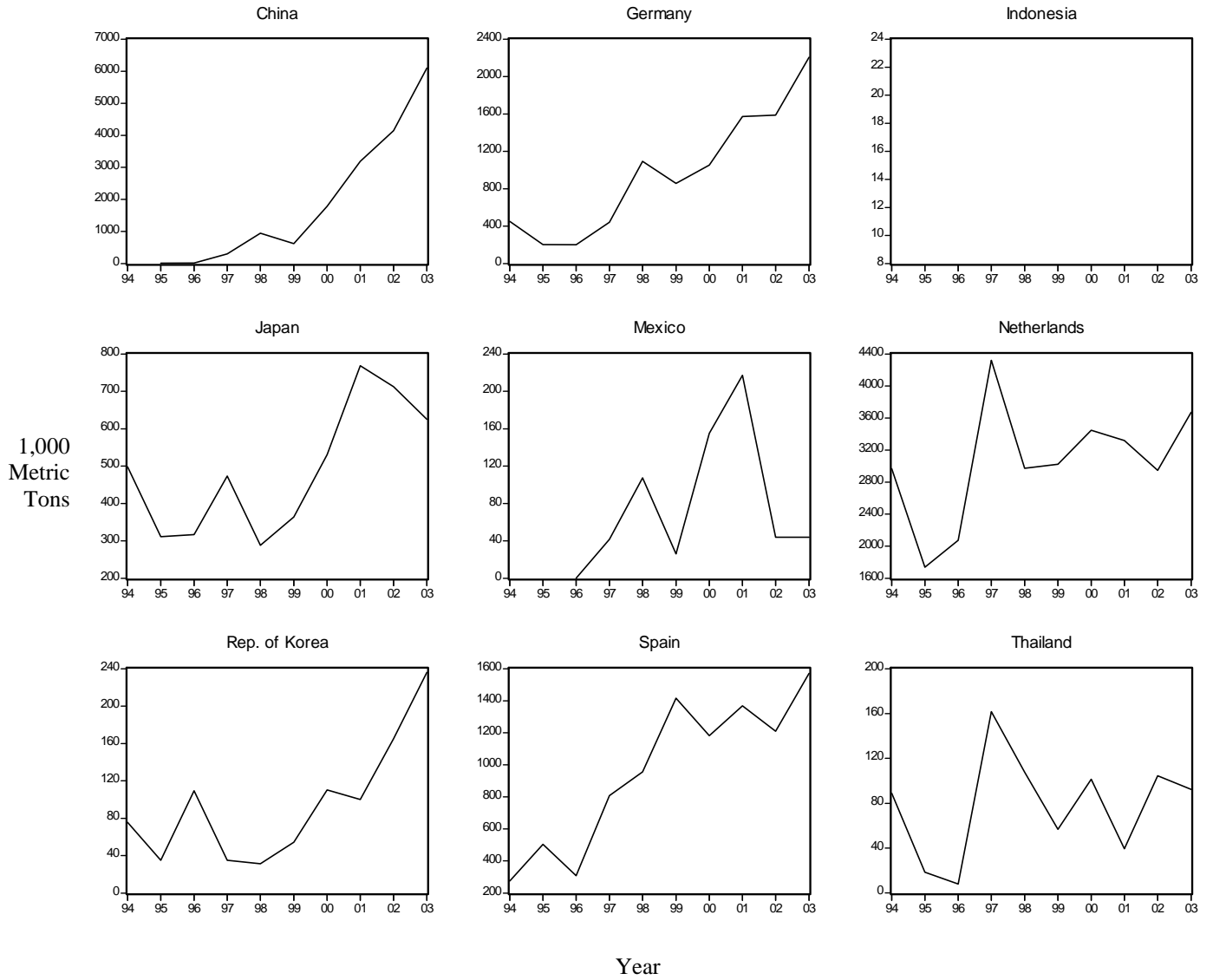


Figure 2. Exports of Soybeans from Brazil to Major Importing Countries (1994-2003)

Note: Empty plots or spaces are for countries and periods with missing information.

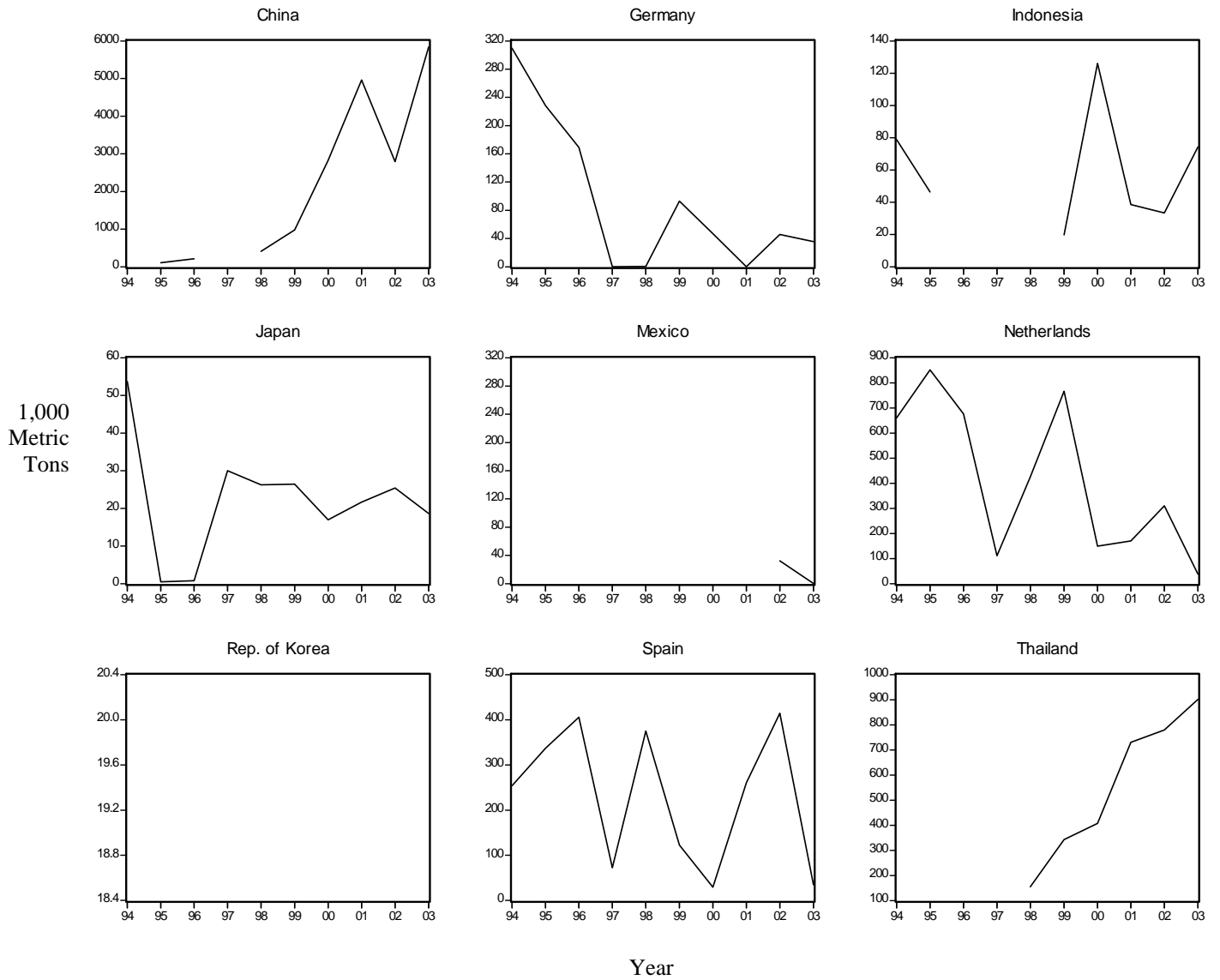


Figure 3. Exports of Soybeans from Argentina to Major Importing Countries (1994-2003)

Note: Empty plots or spaces are for countries and periods with missing information.

ISSUES IN U.S. SOYBEAN TRADE

Genetically Modified (GM) Soybeans

In 1996, the United States introduced the Roundup Ready soybean, a GM crop with immunity to the herbicide glyphosate, for commercial production. Although Argentina and recently Brazil have legalized the production of GM soybeans (Matthey, Fabiosa, and Fuller, 2004), the United States leads in planting of GM soybeans, accounting for 87 percent on the total soybean producing area during 2005 (USDA ERS, 2005). Consumer concerns regarding GM products have been cited as a reason for decreased exports of U.S. soybeans, especially to the EU, Japan, and Korea (Ames, 2001; Nielsen and Anderson, 2000). However, other researchers have argued that changes in soybean prices are still the main factor in determining bilateral trade flows of soybeans (Ballenger, Bohman, and Gehlhar, 2000; Cunningham and Unnevehr, 1999).

Exchange Rates and Prices

Researchers have concluded that currency devaluations by Brazil and Argentina have been important factors in the decreased competitiveness of U.S. soybeans in world markets (Sampaio, Costa, and Gunter, 2003; USDA ERS, 2000). Table 2 presents nominal exchange rates between the United States and Brazil and Argentina. In the case of Brazil, substantial currency devaluation in relation to the U.S. dollar commenced in 1997. Further devaluations continued as a result of governmental measures in response to the financial crises in Asia and Russia, which increased concern among international investors and promoted the outflow of capital from Brazil (USDA ERS, 2000). In the case of Argentina, currency devaluations began in 2002 as a result of the country's domestic financial crisis.

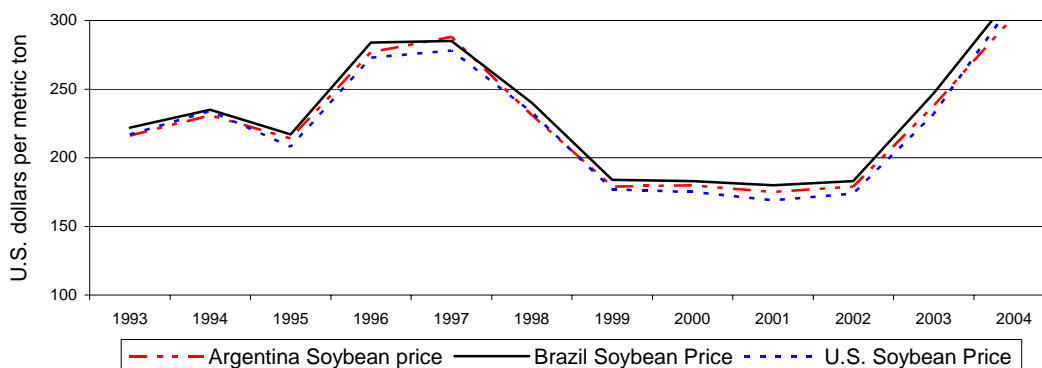
Table 2. Nominal Exchange Rates Between the United States and Brazilian "Real" and Argentinean "Peso"

Year	Reals per U.S. dollar	Pesos per U.S. dollar
1994	0.639	0.999
1995	0.918	1.000
1996	1.005	1.000
1997	1.078	1.000
1998	1.161	1.000
1999	1.815	1.000
2000	1.830	1.000
2001	2.358	1.000
2002	2.921	3.063
2003	3.077	2.901
2004	2.927	2.922

Some researchers have reported that currency adjustments could have strengthened the agricultural exports of Argentina and Brazil by creating a price advantage over other competitors. For instance, Rosson, Adcock, and Hobbs (2001) showed that, during 1996-1998, a 20 percent appreciation of the U.S. dollar led to an 8 percent increase in U.S. soybean prices in Japan (from 989 ¥/bu to 1,068 ¥/bu). Consequently, Japanese purchases of Brazilian soybeans increased.

Figure 4 presents the soybean export prices for the United States, Brazil, and Argentina. It can be seen that price behavior for the three countries is almost identical. The plots show a trend of

increase from 1993-1997, followed by a decline in 1998 and 1999, a stable period during 2000-2002, and an exponential increase since 2003. From 1993 to 2004, average export prices have been higher for Argentina, at 232 dollars per metric ton, followed by Brazil and the United States at 226 and 224 dollars per metric ton, respectively. Because of the strong similarity in export prices of major producers, exchange rate strategies from one exporter could make a substantial difference in the price paid for its soybeans by importing partners.



Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Average
Brazil	216	231	214	277	288	231	179	180	175	179	238	303	226
Argentina	222	235	217	284	285	240	184	183	180	183	247	320	232
U.S.	217	234	208	273	278	233	177	175	169	174	232	314	224

Figure 4. Nominal Soybean Export Prices for Argentina, Brazil, and the United States (1993-2004)

Note: U.S. price quoted from NO1, yellow cash central Illinois; Brazil price Rio Grande, FOB; and Argentina price is FOB Buenos Aires.

Source: USDA, FAS.

MODEL

Our model is developed from a general import demand function with the inclusion of exchange rate variables, based on work presented by Cushman (1986) and Jin, Cho, and Koo (2004). The model explains soybean imports by country i from a specific exporter j (M_i^j) as a function of country i 's total soybean imports (TM_i), country j 's soybean export price (P^j) relative to a weighted average of competitors' export prices (P^c), the exchange rate between importer i and exporter j (XR_i^j), and the exchange rate between importer i and a weighted average of other exporting countries (XR_i^c). The model is specified as:

$$M_i^j = f(TM_i, P^j / P^c, XR_i^j, XR_i^c) \quad (1)$$

The model assumes that imported soybeans are imperfect substitutes for domestically produced soybeans in importing countries (imperfect substitute model) and that imported soybeans from different sources are homogeneous (Goldstein and Khan, 1985; Gotur, 1985). Importing countries decide the total amount of soybeans to purchase before deciding the amount of product

imported from alternative suppliers. Therefore, the volume of soybean imports from a specific supplier will depend on the total amount of soybeans purchased from the world.

Export prices of soybeans in exporting countries are included based on common demand theory applied to trade models, where imports in importing countries are a function of an exporting country's price and the price of its competitors (Lord, 1991). Because of the high correlation between soybean export prices of the United States and its major competitors, Argentina and Brazil (Figure 4), the price variable is expressed as a ratio to avoid multicollinearity problems.

As previously mentioned, changes in exchange rates are expected to affect the actual price paid for imported agricultural products. As a result, as long as products are substitutable, importing countries will make adjustments in trade, manifested in changes in preference for alternative suppliers (Anderson and Garcia, 1989). Therefore, in our framework, soybean importers are concerned about their currency value relative to those of major supplying countries. For instance, Chinese importers are concerned about the value of the Yuan relative to the U.S. dollar, as well as the value of the Yuan relative to the Brazilian real and the Argentinean peso. The concept of including exchange rates of competing third countries in bilateral trade models, the "third-country effect", was introduced by Cushman (1982) and extended by Jin, Cho, and Koo (2004). Importer's income is not included in the model, since changes in aggregate income should not directly affect sources of imports, but only its level of aggregate imports (Alston et al., 1990).

Based on Equation 1, two import demand equations are specified; one for the quantity of soybeans imported from the United States (US) and another for the quantity of soybeans imported from the rest of the world, mainly Argentina and Brazil (AB). For the United States, the introduction of GM soybeans in 1996 may have been an important factor for the lost of export sales to major importing countries. Therefore, for the U.S. import demand equation, the lag of the percentage area of GM soybeans planted (GMS_{t-1}) was used to represent the adoption of GM soybeans in the United States. The empirical specification of the equations is as follows:

$$\ln M_{i,t}^{US} = \alpha_0 + \alpha_1 \ln TM_{i,t} + \alpha_2 \ln P^{US} / P^{AB}_{i,t} + \alpha_3 \ln XR_{i,t}^{US} + \alpha_4 \ln XR_{i,t}^{AB} + \alpha_5 \ln GMS_{t-1} + \mu_{i,t} \quad (2)$$

$$\ln M_{i,t}^{AB} = \beta_0 + \beta_1 \ln TM_{i,t} + \beta_2 \ln P^{AB} / P^{US}_{i,t} + \beta_3 \ln XR_{i,t}^{AB} + \beta_4 \ln XR_{i,t}^{US} + \varepsilon_{i,t} \quad (3)$$

In these equations, \ln stands for the natural log of the previously described variables and $\mu_{i,t}$ and $\varepsilon_{i,t}$ are the error terms for the United States and Argentina and Brazil equations, respectively.

The error terms are assumed to be independent from the explanatory variables and normally distributed. The i index represents the importing countries, including China, Germany, Indonesia, Japan, Mexico, the Netherlands, Korea, Spain, and Thailand, and t indexes time periods.

It is expected that an increase in the total imports of soybeans in an importing country will include increased imports of soybeans from major exporters. An increase in the U.S. soybean price, while the weighted average export price of competitors remains constant, would reduce the demand for U.S. soybeans. In contrast, an increase in the weighted average price, relative to the U.S. price, would increase soybean demand from the United States. However, if an increase in a country's imports from an exporter is large, it would affect price of soybeans in the exporting country. In this case, the price is endogenous and has a positive relationship with imports. A

rise in the value of the U.S. dollar, with respect to importers' currencies, results in an increase in the actual price paid for U.S. soybeans, thereby reducing the quantity demanded from the United States. Similarly, a decrease in the U.S. dollar value is expected to increase the quantity of soybeans demanded from the United States. An appreciation of the Argentinean and Brazilian currencies, relative to currencies of importing countries, will increase the price of their soybeans, causing increased demand from other soybean suppliers, such as the United States. However, if Argentina and Brazil depreciate their currencies, this would make their soybeans more attractive, and consequently increase their sales to importing countries. Finally, an increase in the adoption of GM soybeans is expected to reduce the demand for U.S. soybeans.

ESTIMATION PROCEDURE

Economic instability in Brazil and Argentina during the end of the 1980s and the early 1990s affected the data required for our analysis. The span of time available for our estimations was limited to 10 years per importing country. Therefore, pooling time series and cross-sectional units (panel data) provided a richer alternative for our estimation.

The import demand of soybeans from the United States and Argentina and Brazil can be simultaneously affected by some factors which were not included in Equations (2) and (3). Therefore, these equations are expected to be related through the error terms, such that $\text{cov}(\mu_{i,t}, \varepsilon_{i,t}) \neq 0$ (contemporaneous correlation). Under this condition, Zellner (1962) showed that there is an efficiency gain if the equations are simultaneously estimated.

Correlation of some of the right-hand side variables with the error term (endogeneity) is a potential econometric problem. In our equations, we expect prices and total imports to be endogenous. In the short run, soybean demand by importing countries may affect export prices of soybeans in exporting countries. For this reason, there is the potential of a simultaneous relationship between export prices and imports, causing the price variable to be correlated with the error term. Also, the total imports variable is expected to be endogenous because of omitted factors determining this variable, such as importer's income and prices. Therefore, the total imports variable was instrumentalized using aggregate income, the import price of soybeans, and the import price of corn (Alston et al., 1990). Also, we used the ratio of total soybean exports by the United States and the average of Argentina and Brazil's total soybean exports as an instrument for the ratio of prices. This relationship is expected to be valid, as economic theory suggests a high correlation between export prices and export supply.

The system of Equations (2) and (3) was estimated using a two-way error component three-stage least squares methodology (EC3SLS). The EC3SLS estimator was derived by Baltagi (1981), and it performs better than an instrumental variable estimation in which the endogenous variables are replaced with their predicted values from separated regressions.¹ A time specific effect is included to account for substantial changes during the 1994-2003 period in world soybean trade.

¹ Interested readers can refer to Baltagi (1981) for the details of the estimation procedure.

DATA AND SOURCES

The data used in this study consist of the volume of soybean imports from Brazil and Argentina and the United States by nine major importing countries: China, Japan, Germany, Spain, the Netherlands, Mexico, Thailand, Indonesia, and Korea. Information about soybean imports from Argentina and Brazil was not uniform across the period under study; therefore, this variable was computed from the difference between total imports and imports from the United States. The data are annual for the period 1994-2003, resulting in 90 observations. Soybean imports and value by the nine importing countries were obtained from the United Nations database COMTRADE. Export prices of soybeans and total exports of soybeans were collected from the USDA Foreign Agricultural Service (FAS). The import prices of soybeans and corn were computed by dividing total value by volume. Prices and income were converted into real values using CPI and GDP deflators, respectively. These data were acquired from the International Monetary Fund (IMF). The nominal exchange rate between the United States and Argentina, the United States and Brazil, and the United States and the nine importing countries were obtained from Exchange Rates and Agricultural Trade data set published by the USDA Economic Research Service (ERS). The exchange rates were expressed in terms of importer's currency per unit of exporter currency. The percent of GM soybeans planted in the United States was obtained from the USDA ERS.

Stationary Properties of the Variables

Recently, a line of research has been developed to study the stationary properties of variables in panel data (Breitung and Meyer, 1994; Im, Pesaran, and Shin, 2003; Pedroni, 2004; Baltagi, 2005). We evaluated the stationarity properties of our variables to analyze the potential of spurious regression by implementing the Im, Pesaran, and Shin (IPS) and the Fisher ADF tests (Table 3). In general, at the 10 percent level, our analysis did not find statistical evidence of unit roots for soybean imports from the United States and Argentina and Brazil and total soybean imports. The IPS test found the ratio of prices to follow a stationary process with a linear trend. Contrasting results were found for the exchange rates. Both tests found the exchange rate variables to have a unit root under the presence of a constant and a time trend, but failed to detect unit roots under the presence of a constant. From these results, we conclude that there is not enough evidence of non-stationarity in the evaluated variables, and therefore, inferences from our estimations may not be affected by the risk of spurious regression.

Table 3. Results of Panel Unit Root Tests.^a

Test	Variables	Constant	Constant and Trend
Im, Pesaran, and Shin	Soybean imports from the United States	-2.3488 *** ^b (0.0094)	-1.98751 ** (0.0234)
	Soybean imports from Brazil and Argentina	-1.4007 * (0.08)	-2.7229 *** (0.0032)
	Total soybean imports	-2.09771 ** (0.018)	-2.9290 *** (0.0017)
	Ratio of export prices between the United States and Brazil and Argentina	-1.2082 (0.11)	-2.7895 *** (0.0026)
	Exchange rate between importers and the United States	-3.3660 *** (0.0004)	0.0460 (0.5183)
	Exchange rates between importers and Brazil and Argentina currencies ^d	-1.3176 (0.09) *	0.1364 (0.5542)
Fisher Augmented Dickey-Fuller	Soybean imports from the United States	38.8298 *** (0.0030)	44.0 *** (0.0006)
	Soybean imports from Brazil and Argentina	33.7866 ** (0.0134)	53.8783 *** (0.0000)
	Total soybean imports	34.1605 ** (0.0120)	38.3955 *** (0.0034)
	Ratio of export prices between the United States and Brazil and Argentina	40.9707 *** (0.0015)	40.5417 *** (0.0018)
	Exchange rate between importers and the United States	43.1147 *** (0.0008)	19.8179 (0.3432)
	Exchange rates between importers and Brazil and Argentina currencies	32.6338 ** (0.0185)	19.4950 (0.3620)

^a Reported values include the test statistic, and in parenthesis is the probability for the null hypothesis that the variable has a unit root or nonstationarity.

^b ***, **, and * indicate significance at the 1, 5, and 10 percent level, respectively.

EMPIRICAL RESULTS

Results from the estimation using EC3SLS are reported in Table 4. For soybean imports from the United States, all the independent variables are significant and the direction of the effect is correct, except for the price variable. Results suggest that soybean imports from the United States increase as major importers increase their total demand of soybeans. Imports from the United States are negatively affected when the value of the U.S. dollar increases relative to the currency of major importing countries. Moreover, an increase in the ratio of importers' currency relative to the weighted average of Brazil and Argentina currencies, suggesting an appreciation of Argentina's peso and Brazil's real, causes soybean imports from the United States to increase. In contrast, if Brazil and Argentina depreciate their currencies, soybean imports from the United States will be expected to decrease. The adoption of GM soybeans in the United States has decreased the purchases of U.S. soybeans from major importers.

Table 4. Results for Import Demand of Soybeans from the United States and Argentina and Brazil by Major Importing Countries

Variables	Description	Error component three-stage least squares (EC3SLS)	
		United States	Brazil and Argentina
TM	Total soybean imports.	0.95 ** (26.51) ^a	1.68 ** (18.47)
P ^j /P ^c	Ratio of export prices exporter j and its main competitors.	0.24 ** (4.47)	1.06 ** (8.46)
XR ^{i/j}	Exchange rate between importers and the United States.	-0.13 ** (-2.69)	0.79 ** (6.62)
XR ^{i/c}	Exchange rate between importers and Brazil and Argentina.	0.14 ** (3.23)	-0.49 ** (-4.61)
GMS	Percentage of GM soybeans planted in the United States.	-0.05 ** (-3.68)	-----

^a ** indicate statistical significance at the 1 percent level. Numbers in parenthesis are for the *t* statistic.

The export price ratio between the United States and its competitors, Argentina and Brazil, has a positive relationship with imports of soybeans from the United States. The positive relationship is due mainly to the nature of the data in the short-run. Economic theory indicates that in the long-run, the price of soybeans is determined by demand and supply. However, in the short-run, import demand for soybeans is affecting the price under a given supply. Currently, export prices from all major exporters have been increasing as a result of increased world demand for soybeans, mainly by import growth from China. These short-run changes under a given supply result in a positive relationship between export prices and imports.

In the case of soybean imports from Brazil and Argentina, all the variables are significant, and have the expected signs, except for relative prices. The result for the ratio of prices was not expected; the reason for this outcome was explained above. Results indicate that soybean imports from Brazil and Argentina increase due to increased total import demand from importing countries. Results provide evidence that a stronger U.S. dollar compared to importing countries' currencies will increase soybean imports from Brazil and Argentina. In contrast, an appreciation of the Argentinean peso and the Brazilian real, relative to the importers' currencies, is expected to decrease soybean imports from Brazil and Argentina. Under this scenario, importers will favor soybean imports from other countries, such as the United States.

Our results provide evidence that currency depreciation in Argentina and Brazil has resulted in decreased U.S. soybean imports by major importing countries. Because of the similarity between soybean export prices of the United States, Brazil, and Argentina (Figure 4), currency devaluations from the latter two countries could have created an advantage in the actual price paid for their soybeans. Moreover, the estimated parameters for Brazil and Argentina's import demand are higher than the ones for the U.S. import demand (Table 4). This result favors Brazil and Argentina, as their soybean exports may be more responsive to income and price strategies oriented to improve their market shares.

Although the cost of producing soybeans is lower in Argentina and Brazil than in the United States, there are still some problems in terms of financial structure, land limitations, and internal transportation constrains (Dohlman, Schnepf, and Bolling, 2001). These may restrict Argentina and Brazil in producing the amount of soybeans necessary to cover increased world demand. Therefore, other competitors, such as the United States, Paraguay, and Uruguay, are still increasing export volumes, but not in the same proportion as Argentina and Brazil.

SUMMARY AND CONCLUSIONS

The objective of this study was to evaluate the impact of U.S. trade of soybeans following Brazil and Argentina's currency devaluation during 1994-2003. The analysis was performed using a panel data framework for major soybean importing markets: China, Germany, Indonesia, Japan, Mexico, the Netherlands, Korea, Spain, and Thailand. We estimated two soybean import demand equations simultaneously: one for the United States and the other for both Brazil and Argentina. The system was estimated using EC3SLS procedure, assuming endogeneity of total imports and relative prices.

Our results indicate that soybean imports from the United States have been affected by changes in exchange rate. The estimation provides evidence that a stronger U.S. dollar relative to an importer's currency, decreases imports from the United States. Also, our results suggest that depreciation (appreciation) of Brazil and Argentina currencies, relative to major importers' currencies, decreases (increase) soybean imports from the United States. Additionally, increased adoption of GM soybeans in the United States has been a determinant in the decreased performance of U.S. soybean exports. Finally, it is also expected that increases in total imports by importing countries would increase the volume of soybean sales from major producers.

Our results are comparable to previous research from Anderson and Garcia (1989), Chambers and Just (1981), and Sarwar and Anderson (1990). These studies concluded that exchange rate changes have a significant impact on trade of soybeans. Moreover, we also found evidence that

competitors' exchange rate affects U.S. trade of soybeans. Based on our findings, we conclude that effort needs to be directed to developing strategies that improve the cost advantage position of the United States in producing soybeans or strategies that allow quality differentiation that favors U.S. soybeans over other competitors.

References

- Alston, J., C. Colin, R. Green, and D. Pick. 1990. "Whither Armington Trade Models?" *American Journal of Agricultural Economics*. 72:455-467.
- Ames, G. 2001. "Bananas, Beef, and Biotechnology: Three Contentious U.S.-EU Trade Disputes." *Review of Agricultural Economics*. 23:214-222.
- Anderson, M., and P.Garcia. 1989. "Exchange Rate Uncertainty and the Demand for U.S Soybeans." *American Journal of Agricultural Economics*. 71:721-729.
- Ballenger, N., M. Bohman, M. Gehlhar. 2000. "Biotechnology: Implications for U.S. Corn & Soybean Trade." USDA ERS Agricultural Outlook, 24-28.
- Baltagi, B. 1981. "Simultaneous Equation with Error Components." *Journal of Econometrics*. 17:189-200.
- Baltagi, B. 2005. "Econometric Analysis of Panel Data." John Wiley and Sons, LTD. 3th Edition.
- Batten, D.S. and M.T. Belongia. 1986. "Monetary Policy, Real Exchange Rates and U.S Agricultural Exports." *American Journal of Agricultural Economics*. 68:422-427
- Bessler, D.A., and R.A. Babula. 1987. "Forecasting Wheat Exports: Do Exchange rates Matter?" *Journal of Business, Economics and Statistics*. 5:397-406.
- Breitung, J. And W. Meyer. 1994. "Testing for Unit Roots in Panel Data: Are Wages on Different Bargaining Levels Cointegrated?". *Applied Economics*. 26: 353-361.
- Chambers, R. and R. Just. 1979. "A Critique of Exchange Rate Treatment in Agricultural Trade Models." *American Journal of Agricultural Economics*. 61:249-257.
- Chambers, R. and R. Just. 1981. "Effect of Exchange Rates Changes on U.S. Agriculture: A Dynamic Analysis." *American Journal of Agricultural Economics*. 63:32-46.
- Cunningham, C. and L. Unnevehr. 1999. "Market Segmentation for Genetically Modified Corn and Soybean Exports." Proceedings of the International Consortium on Agricultural Biotechnology Research Conference, June 1999. Ed. W. Lesser. Pgs. 638-650.
- Cushman, D. 1986. "Has Exchange Risk Depressed International Trade? The Impact of Third-Country Exchange Risk." *Journal of International Money and Finance*. 5:361-379.
- Dolman, E., R. Schnepf, and C. Bolling. 2001. Soybean Production Costs and Export Competitiveness in the United States, Brazil, and Argentina. USDA ERS Oil Crops Situation and Outlook OCS-2001.
- Goldstein, M. and M. Khan. 1985. "Income and Price Effects in Foreign Trade." In Handbook of International Economics, ed. by Ronald W. Jones and Peter B. Kenen. North Holland, pp1042-1099.

- Greenshields, B. 1974. Changes in Exchange Rates: Impact on U.S. Grain and Soybean Exports to Japan. USDA ERS For. Agr. Rep. 364, July 1974.
- Gotur, P. 1985. "Effects of Exchange Rate Volatility on Trade: Some Further Evidence". International Monetary Fund (IMF) Staff Papers. 32:475-512.
- Haley, S.L., and B.Krissoff. 1987. "U.S. Grain Exports and the Value of the U.S. Dollar." *J. Agr. Econ. Res.* 39:12-21.
- Im, K., H. Pesaran, and Y. Shin. 2003. "Testing for Unit Roots in Heterogeneous Panels." *Journal of Econometrics.* 115:53-74.
- Johnson, P., T. Grennes, and M. Thursby. 1977. "Devaluation, Foreign Trade Controls, and Domestic Wheat Prices. *American Journal of Agricultural Economics.* 59:619-627.
- Jin, H., G. Cho, and W. Koo. 2004. "Third-Country Effects on the Market Shares of U.S. Wheat in Asian Countries." *Journal of Agricultural and Applied Economics.* 36:797-813.
- Klein, M.W. 1990. "Sectoral Effects of Exchange Rate Volatility on United States Exports." *Journal of International Money and Finance.* 9:299-308.
- Langley, S.V., M.Giugale, W.H. Meyers, and C.Hallahan. 2000. "International Financial Volatility and Agricultural Commodity Trade: A Primer." *American Journal of Agricultural Economics.* 82:695-700.
- Lord, M. 1991. "Imperfect Competition and International Commodity Trade." Oxford University Press.
- Maskus, K. 1986. "Exchange Rate Risk and U.S Trade: A Sectoral Analysis." *Federal Reserve Bank of Kansas Economic Review.* 3:16-28.
- Matthey, H., J. Fabiosa, and F. Fuller. 2004. "Brazil: The Future of Modern Agriculture?" Midwest Agribusiness Trade Research and Information Center. Briefing Paper 04-MBP 6.
- Nielsen, C. and K. Anderson. 2000. "Global Market Effects of Alternative European responses to GMOs. Centre for International Economic Studies. Adelaide University, No. 0032.
- Pedroni, P. 2004. "Panel Cointegration: Asymptotic and Finite Sample Properties of Pooled Time Series Tests with an Application to the PPP Hypothesis." *Econometric Theory.* 20:597-625.
- Pick, D.H. 1990. "Exchange Rate Risk and U.S.Agricultural Trade Flows." *American Journal of Agricultural Economics.* 72:694-700.

- Rosson P., F. Adcock, and A. Hobbs. 2001. "Exchange Rate Impacts on U.S. Agriculture and the Potential Role of Dollarization." *Working paper, Center for North American Studies, Department of Agricultural Economics, Texas A&M University.*
- Sampaio L.M.B., Costa E.F., and Gunter L. 2003. "Brazil's Floating Exchange Rate and Competitiveness in the World Soybean Market. *Paper presented at the International Conference of Agricultural policy reform and the WTO: where are we heading? , Capri(Italy), June 23-26, 2003.*
- Sarwar, G. and D. Anderson. 1990. "Estimating US Soybean Exports: A Simultaneous Supply/Demand Approach." *Journal of Economic Studies.* 17:41-56.
- Schnepf, R., E. Dohlman, and C. Bolling. 2001. Agriculture in Brazil and Argentina: Developments and Prospects for Major Field Crops. U.S. Economic Research Service, USDA. Agriculture and Trade Report No. WRS013.
- Schuh, G. 1974. "The Exchange Rate and U.S. Agriculture." *American Journal of Agricultural Economics.* 56:1-13.
- Schuh, G. 1976. "The New Macroeconomics of Agriculture." *American Journal of Agricultural Economics.* 58:802-911.
- United Nations, Commodity Trade Statistics (COMTRADE).
<http://unstats.un.org/unsd/comtrade>.
- U.S. Economic Research Service. USDA. 2005. "Adoption of Genetically Engineered Crops in the U.S." Last accessed October 2005.
- U.S. Economic Research Service. USDA. 2000. "Lower Real Boots Brazil's Agricultural Exports." *International Financial Crises and Agriculture.* WRS-99-3.
- U.S. Economic Research Service. USDA. 2004 (a). "Macroeconomic and Agriculture: Agricultural Trade and Real Exchange Rates." Last accessed October 2004.
- U.S. Economic Research Service. USDA. 2004 (b) "Soybeans and Oil Crops: Background." Last accessed October 2004.
- U.S. Economic research Service. USDA. PS&D Tables (1960-2004).
<http://www.fas.usda.gov/psd/>. Washington, D.C.
- U.S. Foreign Agricultural Service. USDA. PS&D Tables (1960-2004).
<http://www.fas.usda.gov/oilseeds/circular/2005/05-07/toc.htm>. Washington, D.C.
- Zellner, A. 1962. An Efficient Method of Estimating Seemingly Unrelated Regressions and Tests for Aggregation Bias. *Journal of the American Statistical Association.* 57:348-368.