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Determinants of U.S. Soybean Exports to Japan

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DETERMINANTS OF U.S. SOYBEAN

EXPORTS TO JAPAN

By

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This research paper is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable for meeting the research paper requirements for this degree. Acceptance of this research paper does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

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CHAPTER I

INTRODUCTION AND PROBLEM STATEMENT

Among world countries, the United States has proven to be one of the more efficient producers of industrial and agricultural goods in the world. As a result, United States goods have been eagerly sought by other countries and the United States has greatly benefited by exchanging these goods for commodities produced by other nations.

International trade is especially important to the agricultural sector of the United States' economy. Agriculture is the United States' largest industry and its continued growth depends on export trade. One out of every 5 dollars the American farmer earns comes from the sale of farm products overseas and almost one harvested acre in three produces for export (United States-Japan Trade Council, p. 2).

One of the most important markets for American agricultural exports is Japan. Japan is an island nation with about 118 million people in an area the size of California. Japan's farmers obtain exceptionally high yields per acre, but because of a critical shortage of land, half of Japan's food, on a caloric basis, is imported. United States is the major exporter of agricultural commodities to Japan (United States-Japan Trade Council, p. 2). In 1981, agricultural exports to Japan from the United States set a record, valued at just over $6.5 billion dollars versus $4.4 billion in 1978 and $3.8 billion in 1977 (see Table 1).

TABLE 1

U.S. Agricultural Exports By Country, 1977-1982*
(in millions of dollars)

	1977	1978	1979	1980	1981	1982(P)
JAPAN	3,857	4,435	5,255	6,111	6,562	5,547
NETHERLANDS	2,124	2,327	2,619	3,412	3,300	3,042
U.S.S.R.	1,037	1,687	2,855	1,046	1,665	1,855
CANADA	1,535	1,621	1,650	1,836	1,989	1,805
KOREA	919	1,148	1,441	1,798	2,008	1,581
TOTAL	$9,472	$11,218	$13,820	$14,203	$15,524	$13,830

P = predicted
*Not adjusted for trans-shipment through Canada, the Netherlands or Belgium.

SOURCE: (1) Japan Economic Institute (JEI) - U.S. Agricultural Exports to Japan: A Review of 1982 Sales, No. 16A, April 29, 1983.
(2) _____, U.S. Agricultural Exports to Japan: A Review of 1981 Sales, No. 15A, April 16, 1982.

Soybeans are one of the most important crops for the U.S. In the history of United States agriculture, there has never been an agricultural commodity which increased in importance as rapidly as soybeans. More than 40 years ago this crop, native to Northwest Asia, jumped into second place in value among all U.S. crops. Corn is the only other crop superior in value. Soybeans are crushed to produce two primary products - meal and oil. Normally about 60% of the value of this crop comes from meal and 40% from oil (Soybean Research Advisory Institute, p. 4).

Japan is the largest single customer for U.S. soybeans. In the calendar year 1978, U.S. soybean exports to Japan totaled 3.9 million metric tons, 93% of Japan's total soybean imports, and were valued at $981 million (United States-Japan Trade Council, p. 5). See Table 2 for Japanese imports from 1979-1983. However, the position of the U.S. as a major soybean exporter to Japan has been eroded by factors such as increased foreign competition and the continued strength of the U.S. dollar.

During 1983, factors such as drought and a Payment-in-Kind (PIK) program resulted in a record decline in soybean production in the United States, from 2.23 billion bushels in 1982-83 to 1.6 billion in 1983-84. Total supplies in 1983 declined 517 million bushels (USDA, Oil Crops, Feb. 1984, p. 2). However, U.S. soybean exports to Japan increased due to overbuying by the Japanese crushing industry which was concerned that the 1983 U.S. drought might lead to tight supplies and even higher prices than actually materialized (Japan

TABLE 2

U.S. Exports of Soybeans, 1979-1982*
(Quantity in thousands of metric ton)

	1979	1980	1981	1982(P)	1983
NETHERLANDS**	4,236	5,392	4,394	5,112	NA
JAPAN	3,707	4,033	4,001	4,068	4,559
WEST GERMANY	1,263	1,451	2,025	2,968	NA
SPAIN	1,774	1,721	1,910	2,044	NA
TAIWAN	1,101	936	1,053	1,405	NA
TOTAL	12,081	13,533	13,383	15,597	4,559

P = Predicted
*Excludes seed and soybean meal.
**Not adjusted for transshipments

SOURCE: (1) Japan Economic Institute (JEI), U.S. Agricultural Exports to Japan: A Review of 1982 Sales, No. 16A, April 29, 1983.
(2) _____, U.S. Agricultural Exports to Japan: A Review of 1981 Sales, No. 15A, April 16, 1982.

Economic Institute 1984, p. 4). At the same time, Argentina and Brazil, taking advantage of the tight supplies of U.S. soybeans, increased their production of this crop. Brazil increased planting by 10% to 9.05 million hectares and Argentina by 16%, to 2.45 million hectares. Production of soybeans in both Argentina and Brazil increased to a total of 20.3 million tons, an 11% increase from 1981-82. Brazilian exports of soybeans reached 1.5 million tons, well above the 1981-82, 1.22 million. Likewise Argentina's exports increased from 1.42 million in 1981-82 to 2.8 million tons in 1983 (USDA, Oil Crops, Feb. 1984, p. 5). The Brazilian Association of Vegetable Industries even proposed that the government accelerate its production of soybean and soybean products to take advantage of high market prices brought on by the 1983 drought in the U.S.

The U.S. dollar has strengthened considerably against most other currencies. This appreciation of the U.S. dollar since 1980 has made U.S. farm exports more expensive than products available from other suppliers. A stronger dollar increases the foreign currency cost of imported food and feed products, reducing net import demand. Also, given the role U.S. loan rates play in setting world prices, an appreciating dollar combined with increasing U.S. support levels has worked to raise the other exporters' local currency trade prices which resulted in a sharp increase in export returns enjoyed by other major traders since 1981. Because of higher returns, foreign competitors have increased their farm output significantly and marketed more aggressively.

JUSTIFICATION

Soybeans are one of the most important export crops in the U.S. However, quantitative information about various factors involved in the determination of the quantity of U.S. soybeans exported to Japan is meager. Further, because of the continuing competition by other countries and the soybeans' importance in U.S. agriculture, producers, trading agencies and government officials need to know the relative importance of the factors affecting soybean exports to Japan. Therefore, the beneficiaries of this research proposal are trading agencies, the U.S. Department of Agriculture, researchers and soybean producers.

OBJECTIVES

The overall objective of this study is to evaluate the performance of the U.S. soybean export market to Japan.

The specific objectives are:

(1) To examine the trend of soybean exports to Japan from 1970-1983.

(2) To determine the major factors affecting U.S. soybean exports to Japan.

PROCEDURES

The first step was in relation to the trend in soybean exports. Under this objective, an examination of trends of the U.S.

soybean exports to Japan in the last 13 years (1970-1982) and review of major factors causing such trends (decrease or increase) was carried out.

The second step was in relation to the second objective. To accomplish this objective, a regression model was developed in which the dependent variable was the quantity of U.S. soybean exports to Japan each year and independent variables were: (1) total population in Japan each year, (2) the exchange rate, (3) Japanese GNP in current dollars, (4) the U.S. price of soybeans, (5) domestic production of soybeans in Japan, (6) effect of complementary products (U.S. price of corn), (7) Japanese aggregate production of livestock, (8) Brazilian production of soybeans, (9) price of U.S. soybeans in yen, and (10) time trend. The regression function was estimated using a SAS program on the mainframe computer.

Data in achieving the first and second objectives were obtained from the same sources of information. Specific information on the dependent variable and the first through the ninth independent variables was obtained from the Yearbook of International Trade Statistics, The World Population, Commodity Yearbook, The Europa Yearbook, Federal Reserve Bulletin and Agricultural Statistics.

PLAN OF PAPER

The literature review is contained in Chapter II, and Chapter III consists of the development of the model. Definitions and econometric and theoretical importance of each selected independent variable used to develop a multiple regression are also explained in this

Chapter. In Chapter IV, the results from the model are examined and compared. In Chapter V, the conclusions of the study and recommendations for further studies in the area of soybean export markets are presented.

CHAPTER II

REVIEW OF LITERATURE

In the last two decades, many studies on agricultural trade have been carried out. Different authors have researched different aspects of agricultural trade in specific countries and across groups of countries. In most of the literature reviewed in this section, the authors have concentrated on the export aspect of agricultural trade. They have examined the variable factors which could determine the level of agricultural commodity being exported from one country to the others. The literature has been reviewed from two different angles, those involving regression models and those related to Japanese export demand for U.S. soybeans and other agricultural commodities from other countries.

JAPANESE EXPORT DEMAND

Houck, Ryan and Subotink (1972) developed a multiple regression model for analysis and estimation of U.S. soybean exports to a region. One of the selected regions in the study was Japan.

In their model, U.S. exports of soybean in million bushels (crop year) have been treated as a dependent variable. Independent variables were: U.S. farm price of soybeans in dollars per bushel (crop year average), Japanese imports of Chinese soybeans in million bushels, real national income in thousand billion yen and Japanese soybean production in million bushels.

The authors found that the price of soybeans had a negative sign and was a strong explanatory variable for U.S. soybean exports. They said that a ten cent change in the U.S. farm price of soybeans resulted in an estimated one million bushel change, in the opposite direction in U.S. exports of soybeans to Japan. They also found that Japan's domestic production of soybeans is negatively related to U.S. soybean exports to Japan. The authors indicated that imports from the United States were more responsive to Japanese soybean production with a large coefficient than to soybean imports from China. Income had a positive sign and it explained 93% of the variation in U.S. exports of soybeans to Japan. The R^2 for the model was (0.98) which is very high.

Capel and Rigoux (1974) did a similar type of study as Houck, et. al. They developed a multiple regression model to identify factors having a bearing on Japan's demand for Canadian wheat. The dependent variable in their model was identified as quantity of wheat imported by Japan in each year (1959-1970) as a function of lagged domestic production in Japan, a time variable which was selected by authors to allow for unspecified and/or unquantified factors which cause shifts in import demand and, finally, average price of wheat imported by Japan from all suppliers in each year.

The authors indicated in their results that the coefficient of price was negative, as expected, but not significant. The coefficient of lagged domestic production was negative and significant at the 5%

level. The trend variable was also significant at the 5% level. The export demand equation was well specified with 0.95 for R^2.

In a study conducted by Goldstein and Khan (1978) a multiple regression model on the demand for total exports has been developed. In their model the world demand of an individual country's exports is specified in log linear form. The dependent variable was quantity of exports demanded depending on price of exports, weighted average of the export prices of the country's trading partners and weighted average of the real incomes of the country's trading partners.

The model has been applied to Japan using its aggregate exports or imports for the period 1955-1970. Their findings showed that the estimated price elasticity carried an unexpected positive sign. The estimated income elasticity had the expected positive sign and was significantly different from zero at the 1% level. The export demand equation seemed to be well specified judging by the value of R^2 obtained (0.94).

MULTIPLE REGRESSION MODELS

Lundborg (1981) applied Goldstine's and Khan's (GK) model to Swedish exports for the period 1960-1976. His results differed from GK's findings in the case of Japan. Lundborg's results showed an expected negative sign for estimated price elasticity. However, the sign of estimated income elasticity was positive as was the case for Japan in the GK's study. Lundborg said both estimates were significant at the 1% level.

In a study conducted by Carthcart and Donald (1966) a multiple regression model was developed. The main emphasis was devoted to statistical analysis of the major economic variables that influence both Foreign Free World (FFW) countries' cotton consumption and U.S. exports of cotton to these countries in the post World War II period (1948-1963). Data for some FFW countries were not available, so 43 countries for which most of the necessary economic data were available were selected by the authors.

Mill consumption of cotton in 43 countries was treated as a dependent variable. Independent variable were: the export price of U.S. cotton, per capita real income of the 43 countries, and mill consumption of non-cellulosic fibers in the 43 countries.

A least squares regression was run and the authors said that all of the coefficients were statistically significant at the 5% probability level with the exception of non-cellulosic fiber consumption. About 85% of the variation in FFW mill consumption of cotton during 1948-1963 was explained by the regression equation.

Fowler (1963) attempted to analyze the pattern of world cotton production, consumption, and trade in relation to the export demand for the United States. He considered demand for exports from the U.S. as a function of export price, demand for mill consumption in importing countries and the supply of cotton from all other countries except the United States.

Fowler considered demand for mill consumption in the importing country as a function of local price of the importing country expressed in U.S. currency, its total population, per capita income and the nature of competition between cotton and other fibers. However, he presented the supply of all cotton from other countries as a function of domestic price of foreign supplies in U.S. currency, operation of government programs in the U.S. and acreage and yield per acre in those foreign countries. The author's results were not presented in the form of a multiple regression equation.

Adams, Eguchi, and Schlochtern (1969) conducted a study on important factors in determination and formulation of an export function. They built a multiple regression model with the dependent variable as the volume of commodity exports of a country. Independent variables were: movements of the market (changes in market share), relative export prices, relative pressure of demand, world business activity plus trends and dummy variables.

They applied this model to nine EEC countries and the authors' results indicated that the predominant element in export determination was the movement of market since the coefficient estimated had a value close to unity. The sensitivity of exports to price in the short run was low and the coefficient was less than unity. According to the authors, the pressure of demand was not an important explanatory factor.

The information presented in this review indicates that there are different views on the major factors which could determine the amount of exports of an agricultural commodity from one country to the others. In the next Chapter, a model is developed which is used to help measure the importance of selected major factors in determination of quantity of soybeans exported from the U.S. to Japan during 1970-1982.

CHAPTER III

DEVELOPMENT OF THE MODEL

To accomplish the objectives of this study a multiple regression model was developed. Factors suggested by economic theory and the literature review to be important in determining the quantity of U.S. soybean exports to Japan were included in this model. Thirteen years of data (1970-1982) were used. This model is presented to quantify the effects of selected factors on the quantity of soybeans being exported from the U.S. to Japan.

The model is:

$$QSX = f(P, EXR, I, PS, JB, PC, JL, BSP, PSY, T)$$

where QSX = Annual quantity of U.S. soybean exports to Japan in 1000 bushels.

P = Annual population of Japan in 1000's.

EXR = Exchange rate, currency (yen) unit per dollar.

I = Annual GNP for Japan in billion of current dollars.

PS = Lagged seasonal average price of soybeans received by U.S. farmers (dollars per bushel).

JB = Japan's domestic production of soybeans in 1000 metric tons.

PC = Seasonal average price of corn received by U.S. farmers (dollars per bushel).

JL = Japan's aggregate production of livestock, in million dollars at constant prices.

BSP = Brazilian production of soybeans in 1000's of metric tons.

PSY = Price of U.S. soybeans in yen per bushel.

T = Time trend.

DEPENDENT VARIABLE

U.S. Soybean Exports to Japan (QSX)

Under objective (1) in this study, the trend of U.S. soybean exports to Japan was examined from 1970-1982. Table 3 shows this trend for the past 13 years.

Some 96% of Japan's soybean imports in 1980 were of U.S. origin which accounted for 19-20% of all U.S. soybean exports in that year (USDA, Foreign Agriculture, 1981, p. 18). Numerous factors interact to determine the quantity of U.S. soybean exports to Japan. Some of these, as indicated in the statement of objectives, are examined in this study.

Based on economic theory, increases in Japan's population, Japan's GNP and Japan's livestock production were hypothesized to increase the quantity of U.S. soybean exports to Japan. On the other hand, increases in U.S. price of soybeans and U.S. price of corn, Japan's domestic production of soybeans, quantity of soybeans produced by other U.S. competitors (Brazil), price of U.S. soybeans in yen and exchange rate (dollar value vs. yen) were hypothesized to decrease the quantity of soybean exports to Japan.

INDEPENDENT VARIABLES

Population (P)

The human population of Japan has been selected as an independent variable because, based on economic theory, it is considered to

TABLE 3

Trend of U.S. Soybean Exports to Japan (1970-1982)

Years	Quantity of Soybeans (1000 Bushel)
1970	102,791
1971	107,379
1972	120,982
1973	98,754
1974	96,893
1975	118,093
1976	118,263
1977	98,967
1978	105,183
1979	105,279
1980	103,849
1981	111,718
1982	124,787

SOURCE: See Appendix, Table 1.

be a demand shifter. Increases in population would cause the demand curve to shift to the right and decrease in population would cause the demand to shift to the right.

Japan's population in 1970 totaled 104 million, increased to 111 million in 1975 and in 1982 it reached 118 million. Japan has an average annual population growth rate of 0.6% (The World Population, 1984, p. 233). If the population continues to grow in the years ahead, the demand curve for U.S. soybeans would shift to the right.

Exchange Rate (EXR)

The U.S. dollar/Japanese yen exchange rate changed several times in 1971-1973 after a long period of stability. The rate had been 360 yen per dollar from April 24, 1949, to August 28, 1971, when the yen floated. Changes that occurred thereafter resulted in a 32% increase in the purchasing power of Japanese yen in the U.S. export market by the end of 1973 (Greenshields USDA, p. 1). Sales of U.S. soybeans to Japan were $26 million higher in 1972 and $48 million higher in 1973 than they would have been without these changes occurring between Japanese yen and U.S. dollar exchange rates (Greenshields USDA, p. 1). Theory indicates that the strong dollar keeps prices of U.S. soybeans high abroad in the currencies of U.S. major import markets. Thus, while U.S. farm soybean prices could fall, the price of soybean exports would rise in the local currencies of many foreign markets including Japan, discouraging import demand. The years 1981-1982 are a good example for this case. This variable is hypothesized to be negatively related to U.S. soybean exports to Japan.

Income (I)

An income variable is included in the model in terms of Japan's gross national product in billions of current dollars. In economic literature, Gross National Product is defined as the market value of all currently produced goods and services during a particular time which are sold through the market, but are not resold.

Based on the promotion of manufacturing industries for the export market, Japan achieved a very high rate of economic growth after 1945. Gross National Product (GNP) grew at an average rate of 10.3% between 1962 and 1972 and in 1971, Japan's GNP became second largest in the world, ranking behind only the U.S. (Soviet bloc countries excluded). Japan's GNP grew at 5.5% annually from 1976-1981 (The Europa Year Book, 1983, p. 654).

The income variable directly measures the effect on U.S. soybean exports of changes in gross national product in Japan. This variable is hypothesized to be positively related to the quantity of U.S. soybean exports to Japan. The diets of Japanese consumers are low in calories obtained from fats and livestock products. Therefore, as income increases, a higher demand for meat consumption would cause an increase in livestock production in Japan. As livestock production increases, demand for U.S. soybeans increases in Japan.

Price of Soybeans (PS)

The demand for U.S. soybeans is influenced directly by the price of soybeans. This variable is introduced into the model in terms of seasonal average price received by U.S. farmers (lagged).

Prices received by farmers rose 17% in the 1974-1975 marketing year to $245 a ton or $6.66 a bushel (Collins-FATUS, 1976, p. 18).

These prices decreased to $4.92 per bushel in 1976 and soybean imports by Japan gained 6.6% over those of 1975 (USDA Foreign Agriculture, 1977, p. 5). A higher price for soybean imports at $6.81 per bushel in 1977 caused Japanese crushers to hesitate to buy soybeans as far in advance as they normally do. Soybean exports from U.S. to Japan declined from 118,263 thousand bushels in 1976 to 98,967 thousand bushels in 1977 (see Appendix, Table 1). As economic theory indicates, this variable is negatively related to quantity demanded; therefore, higher prices received by farmers are expected to decrease quantity demanded of U.S. soybean imports in Japan.

Japan's Domestic Production (JB)

In 1976-1977 Japan's domestic production of soybeans decreased to 126,000 tons in comparison to 507,000 tons in 1955-1956 (Bale and Greenshields USDA, p. 15). This sharp decline in production occurred despite remarkably high prices guaranteed by the Japanese government for domestically produced beans ($11.55 per bushel for the 1973 crop). And it happened despite the direct payment to farmers ($530 per acre in 1973) for diversion of rice land to soybeans (USDA, Who Buys Our Farm Products? p. 8). Meanwhile, due to increased GNP in Japan and a continuous increase in livestock production, Japan's demand for U.S. soybeans has increased. Japan imports more than 80% of its soybeans from the United States. However, by 1985-1986 plans for acquiring farmland and developing joint farm ventures in other areas such as

South Korea call for increasing the level of domestic production to 60% of quantity demanded (Bale and Greenshields USDA, p. 15). Domestic production in Japan is expected to be negatively related to quantity of soybean exports from U.S. to Japan.

Price of Corn (PC)

In 1978 the U.S. exported 8.5 million metric tons of corn worth $915 million to Japan. Imports of U.S. corn by Japan continued to expand, climbing from 11.4 million metric tons in 1979 to 13.6 million metric tons in 1981 (Japan Economic Institute, April 16, 1982, p. 1). This increase in corn imports resulted from increased production and consumption of beef and poultry due to increased income.

The United States supplies Japan with over 80% of its corn imports. Three-fourths of the corn imported from the U.S. is used to satisfy the Japanese demand for livestock and poultry mixed feed (Japan Economic Institute, May 11, 1984, p. 3). Therefore, relative prices of soybean and corn are a consideration for the manufacturer and user of feed concentrates for livestock since nutritional requirements can be met from combinations of corn (carbohydrate) and soybean (protein). Corn and soybeans are complements and therefore, based on economic theory, it is hypothesized that the price of corn and the quantity of soybeans exported from U.S. to Japan would be negatively related.

Livestock Production (JL)

Animal population could be taken as another shifter of demand. Due to lack of reliable data on livestock numbers, this variable has been looked at in terms of Japan's aggregate livestock production each year in million dollars at constant dollars. About 90% of the U.S. soybean exports to Japan were crushed, and the remainder were used in the manufacture of soy food products (Greenshields USDA, 1975, p. 81). Table 4 shows the percentage of the total soybean meal used in various animal feeds in Japan in 1974.

The limited land available in Japan has been a strong reason for domestic increases in poultry as well as pork production over the past two decades. Broiler meat production in Japan moved from 17,000 metric tons in 1960 to 310,000 metric tons in 1970 to more than 1 million metric tons in 1980 (Feedstuffs, p. 23).

Brazilian Soybean Production (BSP)

U.S. soybean exports are seriously challenged by foreign competition in soybean production. The big challenge has come from Brazil whose soybean production has escalated in the past decade.

Although the U.S. continues to be the leading world producer of soybeans, the U.S. share has dropped from 74% in 1967-1969 to 63% in 1980-1982. Brazil and Argentina increased their share of the world production from about 2% in 1967-1969 to 21% 1980-1982 (Soybean Research Advisory Institute, p. 3).

Brazil is a competitive supplier in the Japanese soybean market. In 1974 soybean imports from Brazil were dwarfed by those from the United States, yet they did rise from 14,800 metric tons in 1972 to 184,800 in 1973. This largely accounted for a slipping of the

TABLE 4

Percentage of the Total Soybean Meal Used in Various Animal Feeds in Japan (1974)

Type of Feed	% of Total Soybean Meal
CHICKEN	51
HOG	33
DAIRY	11
BEEF CATTLE	3
OTHER	2
TOTAL	100

SOURCE: Bruce L. Greenshields - Japanese Market Demand and Competition in 1974, Foreign Agricultural Trade of the United States, 1975, p. 81.

U.S. market share in Japan in 1973 to 88% from 92% in 1972 (USDA Foreign Agriculture, June 1974, p. 5).

During 1983, because of the Payment-in-Kind program and drought, U.S. soybean production decreased to 1.6 billion in 1983-1984 from 2.23 billion bushels in 1982-1983. Brazil increased plantings by 10% in 1983 and Brazilian exports of soybeans to Japan reached 1.5 million tons in 1983, in comparison to 1.22 million in 1981 (USDA, Oil Crops, May 1984, p. 6). With rapidly growing production, Brazil is likely to emerge further as a competitor in the U.S. soybean market in Japan.

Price of U.S. Soybeans in Yen (PSY)

This variable has been calculated by multiplying the seasonal average price of soybeans received by U.S. farmers in dollars per bushel by the exchange rate (yen per dollar). Collected data (see Appendix, Table 1) show that neither the price of soybeans nor the exchange rate variable have followed a trend in the last two decades. They have been increasing or decreasing unevenly. So this approach has been taken in order to combine the effects of these two variables. The price of soybean in yen will more closely approximate the price faced by the Japanese importer than will the prices received by American producers.

Time Variable (T)

Time trend has been included in the model to account for shifts in markets over time.

CHAPTER IV

RESULTS AND DISCUSSION

In this Chapter, the results of the multiple regression model are presented. Discussion of the results is also included.

A Leaps procedure with an SAS interface was used to choose the best ordinary least squares regression equation. The Leaps procedure finds subsets of regression models having the largest R^2 for each number of regressors. For the data in the study, ten subsets of models (including from one to ten variables) were selected by the procedure. Based on the highest R^2, adjusted R^2, and number of significant coefficients, the best model included five predictors: population, income, U.S. price of corn, price of U.S. soybeans in yen, and exchange rate. The overall regression was statistically significant at the 0.15 level (see Table 5). Sixty-two percent of the variation in the quantity of U.S. soybean exports to Japan is explained by the selected variables, as measured by the R^2 statistic. While lower than the findings of previous researchers in the area of export demand, the R^2 value for the estimated regression is reasonable.[1] In addition, two of the parameters are significant at 0.05 level, two at 0.01 level and only one parameter was not significant.

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[1]For comparison see: Houck, et. al., Soybeans and their products, 1972, p. 238. Capel and Rigoux, Analysis of export demand for Canadian Wheat, Canadian Journal of Agricultural Economics, July 1984, p. 8. Goldstine and Khan, The Supply and Demand for Exports, The Review of Economics and Statistics, May 1978, p. 275.

TABLE 5

Results of the Multiple Regression Analysis
(Dependent Variable = QSX)

Variables	Coefficients	t Statistic
Population (P)	+11.32***	2.88
Income (I)	-87.08**	-2.296
Price of Corn (PC)	+8903.29 N.S.	1.019
Price of U.S. Soybean in Yen (PSY)	-42.56**	-2.289
Exchange Rate (EXR)	+436.71***	3.175
R^2	0.62	
Adjusted R^2	0.35	
F Value	2.29	

<u>Note</u>: *** = Significant at 0.01 level.
** = Significant at 0.05 level.
N.S. = Not Significant

Population (P) has an expected positive sign and is statistically significant at 0.01 level. This implies that an increase in population is associated with an increase in the demand for U.S. soybeans in Japanese markets.

Income (I) is significant at 0.05 level but negatively related to U.S. soybean exports to Japan. Negative sign of this variable contradicts economic theory and the literature reviewed (Houck et. al, 1972, Capel and Rigoux, 1974).

Price of Corn (PC) was not significant but had an expected negative sign.

Price of U.S. Soybean in Yen (PSY) is significant at 0.05 level and negatively related to U.S. soybean exports to Japan as expected. This is consistent with Houck, et. al. (1972) and Capel and Rigoux (1974) earlier findings.

Exchange Rate (EXR) is significant at 0.01 level but positively related to the quantity of U.S. soybean exports to Japan. The positive sign of this variable contradicts economic theory.

In comparing the results of this study to similar research findings, a number of observations are in order. As indicated before, the coefficient of determination, R^2 at 0.62, is reasonable but lower than the R^2 of similar studies, Goldstine and Khan (1978), Cathcart and Donald (1966), and Caple and Rigoux (1974) with values of 0.94, 0.85, and 0.95 respectively. Three of the five variables included in the model had the expected sign. Four variables were significant.

This study included more variables in the final model selected than had most previous studies. However, some of the variables initially chosen for analysis on the basis of theory and literature review proved to be insignificant. These variables were year, price of soybeans received by U.S. farmers, Japanese production of soybeans, Japanese livestock production, and Brazil production of soybeans. Previous studies had shown some of these variables to be significant, especially the price of soybeans. However, the price of soybeans received by U.S. farmers was integrated into the price of U.S. soybeans in yen, a variable included in the final model which was significant.

CHAPTER V

SUMMARY AND CONCLUSIONS

Thirteen years of data were analyzed using a single equation, multiple regression model. Five demand variables were used in the final model to explain Japanese export demand for U.S. soybeans. The model was specified and an ordinary least squares method was employed to estimate the parameters of the model.

The results obtained were statistically significant at 0.01 and 0.05 levels, except for one variable (Price of Corn) which was not significant. The sign on three of the regression coefficients were as expected. Coefficients of income and exchange rate had unexpected signs. Quantity of U.S. soybean exports to Japan were found to be positively related to Population (P), Exchange Rate (EXR), and Price of Corn (PC) and negatively related to Income (I), Price of U.S. Soybeans in Yen (PSY).

Agriculture is the United States' largest industry and its continued growth depends on export trade. One out of every 5 dollars the American farmer earns comes from the sale of farm products overseas. Japan is one of the most important markets for American agricultural exports. Japan is the largest single customer for U.S. soybeans. In calendar year 1978, U.S. soybean exports to Japan totaled 105,183 thousand bushels, 93% of Japan's total soybean imports and valued at $981 million. Some 96% of Japan's soybean imports in

1980 were of U.S. origin, which accounted for 19-20% of all U.S. soybean exports in that year.

Because of accelerated competition from other exporters and soybeans' importance in U.S. agriculture, it is essential that producers, trading agencies and government officials be aware of factors that are affecting the quantity of U.S. soybean exports to Japan. This study provides empirical information which might be useful in understanding the forces that determine the quantity of U.S. soybean exports to Japan.

This study indicated several factors that are of importance in determining the quantity of soybeans imported by Japan from the U.S. While none of the factors are under the direct control of U.S. producers, policymakers can indirectly influence three of the factors through U.S. government policies. Those factors are the price of corn received by U.S. farmers, the price of soybeans received by U.S. farmers, and the exchange rate (the latter two combined in the price of U.S. soybeans in yen).

Researchers may use the results of this study to expand the scope of their studies and may include variables not included herein or may include those variables in a different format in future studies.

To form a more complete picture about the soybean trade, the supply side of soybean exports could be studied. A supply study should include the effects of government policies, both of importing and exporting nations. Policy effects were not integrated into the demand study presented herein, which may explain the insignificance of some variables expected to be significant.

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APPENDIX

TABLE 1 - COLLECTED DATA

YEARS (1)*	Quantity of U.S. Soybean Exports to Japan (Per 1000 Bushels) (2)	Japan's Population (In 1000's) (3)	Gross National Product of Japan (Billion of Current $'s) (4)	Seasonal Average Price Per Bushel Received by Farmer		Japan's Soybean Production (In 1000 MT) (7)	Exchange Rate (Yen Per $) (8)	Price Soybeans In Yen (9)	Japan's Livestock Aggregate Production (In Million $'s at Constant Prices) (10)	Brazilian Soybean Production (In 1000's MT) (11)
				Soybean (5)	Corn (6)					
1970	102,791	104,345	387.6	2.35	1.16	126	358.15	841.65	2,853.9	1,509
1971	107,379	105,697	383.5	2.85	1.33	122	347.47	990.29	3,120.5	2,077
1972	120,982	107,188	199.1	3.03	1.08	127	303.07	918.30	3,245.2	3,666
1973	98,754	108,707	410.1	4.37	1.57	118	270.89	1,183.79	3,273.8	7,876
1974	96,893	110,162	498.4	5.68	2.55	133	291.53	1,655.89	3,527.0	9,892
1975	118,093	111,573	615.0	6.64	3.02	126	296.69	1,970.02	3,615.0	10,810
1976	118,263	112,771	768.2	4.92	2.54	110	296.37	1,458.14	3,702.9	12,200
1977	98,967	113,863	769.4	6.81	2.15	111	267.79	1,823.65	4,040.4	9,534
1978	105,183	114,898	872.7	5.88	2.02	190	208.41	1,225.45	4,392.3	10,240
1979	105,279	115,870	1,000.9	6.66	2.25	192	219.02	1,458.67	4,678.6	15,156
1980	103,849	116,782	1,152.6	6.28	2.52	174	226.63	1,423.24	4,792.8	15,200
1981	111,718	117,648	1,128.0	7.57	3.11	212	220.63	1,670.17	4,760.5	12,835
1982	124,787	118,449	1,213.7	6.37	2.45	213	249.06	1,576.51	4,908.0	14,900

*See Footnotes to Appendix, Table 1.

FOOTNOTES TO APPENDIX, TABLE 1

Column

2 Source: USDA, Agricultural Statistics (Years: 1974, 1977, 1980, 1983) Pages 139, 136, 134.

Note: From 1977-1982 the volume of soybean exports has been converted from metric tons to 1000 bushels by dividing the amount in metric ton by 36.74.

3 Source: U.S. Department of Commerce, World Population 1983, p. 234.

4 Source: U.S. Department of Commerce, Statistical Abstract of the United States 1984, p. 865

The Europa Year Book 1979, p. 643.

Note: Years 1972 and 1973 have been converted from GNP in 1000 million yen at current prices to GNP in billion of current dollars. This has been done by dividing the amount of GNP in 1972 and 1973 by exchange rate in each year.

5-6 Source: USDA, Agricultural Statistics 1983, pp. 129-130.

7 Source: USDA, World Indices of Agricultural and Food Production 1984, p. 100.

8 Source: Federal Reserve Bulletin (Years: 1983, 1980, 1977, 1976).

Note: The years 1970-1978 have been changed from cents per unit of yen to yen per dollar by taking 1 divided by the cost of yen in cent x 100.

9 Note: This variable has been obtained by multiplying the exchange rate by price of soybeans (1970-1982).

10 Source: USDA, World Indices of Agricultural and Food Production (1981), p. 100.

11 Source: Commodity Year Book (Years: 1982, 1983, pp. 320, 318).