AGRICULTURAL IMPORT DEMAND IN LARGE MARKETS: AN AGGREGATE ANALYSIS WITH HIGH AND LOW GROWTH SUB-GROUPS

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INTRODUCTION

Growth in import markets for agricultural products is analytically significant for several reasons: (1) United States farm income is closely tied to export markets; (2) one U.S. economic policy objective is to decrease the U.S. trade deficit; and (3) there is concern about the large expenses involved in overseas market promotion programs by the United States Department of Agriculture (USDA). Several important questions arise regarding global rates of agricultural import growth. Which type of economy or region of the world has the fastest rate of agricultural import growth? Are the largest markets also the fastest growing? Does the U.S. have a significant market share in the markets which are growing fastest? Where should the U.S. spend its limited export promotion funds to receive the greatest return on investment? As growth in the domestic market has become stagnant, U.S. agriculture has been forced to increase sales by increasing exports. Large agricultural import markets that are growing offer a greater opportunity for increasing sales of U.S. agricultural products than smaller markets.

Objectives of the Study

The primary objective of this study is to determine if import demand variables have significantly different impacts on agricultural import demand in large agricultural import markets when different rates of growth in agricultural imports exist. The study group includes China, Italy, Hong Kong, Japan, France, the Netherlands, the German Federal Republic, Belgium-Luxembourg, the United Kingdom, Egypt, Canada, and the United States.

Specific objectives of the study are:

1) To review global trends in agricultural import demand from 1984 to 1989,
2) To review the existing literature on the estimation of single and multiple commodity models of import demand and of export demand,
3) To review the economic theory underlying import demand and demand elasticities, and
4) To econometrically estimate agricultural import demand functions for the study group, as a whole and in groups classified by average annual growth rates of agricultural imports, in order to determine if significant differences exist in the impact of import demand variables on growth groups.

World Agricultural Import Growth

This section discusses global trends in agricultural import growth from 1984 to 1989. First, rates of import growth are compared across major regions (by continent and type of economy). Second, agricultural importers are compared by: (1) market size, (2) the absolute change in their imports, (3) the average annual rates of import growth, and (4) the total rate of import growth over the five-year analysis period. The comparison is done for five categories of countries: large, medium, small, and very small markets, and all countries. Third, the U.S. market share of agricultural commodities is compared in the 15 largest markets and the 15 fastest growing import markets. For all of the comparisons, the dollar value of total agricultural imports was used as the variable of interest.

From 1984 to 1989, the world experienced a total increase in agricultural imports of 36.03 percent. The highest annual rate of growth for this time period was in 1987-88 when imports increased by 12.79 percent (Table I). World imports showed negative growth from 1984 to 1985, but rebounded later for an average annual growth rate of 6.5 percent over the five-year period (Table I).

Economy Type

The agricultural imports of developed economies grew at a rate 66 percent faster than those of developing economies from 1984 to 1989. Developing economies are generally defined as countries with low per-capita incomes whose main imports are basic food requirements. Their infrastructure is typically characterized by underdeveloped capital markets, weak government institutions, and a poor transportation system. Developed economies, in contrast, have high per-capita incomes and a broader base of imports. Their infrastructure has well-developed capital markets, strong government institutions, and a good transportation system. Table I shows the rate of agricultural import growth in major regions by economy type and continental groupings as defined by the Food and Agriculture Organization of the United Nations (FAO). Total agricultural imports as measured by FAO include all raw or processed agricultural products purchased by a country, regardless of product origination. U.S. agricultural export data as measured by Foreign Agricultural Trade of the United States (FATUS) includes only U.S. agricultural sales to other countries. Total agricultural import value encompasses a wide array of products and trading partners for each country considered. The

TABLE I

RATES OF AGRICULTURAL IMPORT GROWTH, MAJOR REGIONS, 1984-1989

Major Region		Percentage Growth Rates 1984-85	1985-86	1986-87	1987-88	1988-89	Annual Avg	Total 1984-89
Economy Type	DEVELOPED ALL	-0.97	12.26	11.58	10.72	2.37	7.19	40.59
	Oceania	0.94	2.67	5.76	18.34	22.34	10.01	58.69
	Western Europe	2.31	20.53	15.54	9.26	-0.03	9.52	55.62
	Other Developed	-10.97	7.24	15.31	27.07	7.85	9.30	50.88
	North America	0.39	6.04	-0.21	4.01	3.05	2.66	13.87
	E. Europe	-6.48	5.06	-1.69	16.84	-3.34	2.08	9.08
	USSR	-6.39	-14.25	6.35	8.60	13.05	1.47	4.80
	DEVELOPING ALL	-9.28	-3.86	7.95	19.68	10.51	5.00	24.52
	Far East	-8.70	0.33	22.28	27.97	9.46	10.27	56.91
	Other Developing	-5.31	9.47	11.34	2.05	3.87	4.29	22.34
	Latin America	-9.91	1.18	-4.67	17.71	10.49	2.96	13.02
	Africa	0.29	-7.28	-3.23	9.57	15.42	2.85	13.14
	Near East	-13.47	-9.71	2.64	13.83	10.45	0.75	0.82
Continent	EUROPE	1.63	19.43	14.47	9.66	-0.22	9.00	52.04
	OCEANIA	-1.04	4.01	6.62	14.34	18.75	8.53	48.99
	ASIA	-11.09	-0.55	15.61	23.38	9.93	7.46	38.64
	N/C AMERICA*	-0.50	2.74	0.42	7.95	5.92	3.31	17.37
	AFRICA	-4.19	-6.33	-2.08	17.53	8.94	2.77	12.52
	SOUTH AMERICA	-16.23	20.40	-12.45	3.22	-1.97	-1.41	-10.65
	WORLD	-3.33	7.96	10.72	12.79	4.37	6.50	36.03

* North and Central America

Note: Annual growth rates were computed as the change in a one-year period divided by the previous year's total agricultural imports and multiplied by 100 to obtain percentages. Absolute change in imports for the five-year period was calculated as 1989 total agricultural imports less 1984 total agricultural imports. Average annual growth rate is the average of the annual growth rates from each one-year period. Total agricultural import growth rate from 1984 to 1989 was determined by dividing the absolute change in imports by the 1984 imports and multiplying by 100 to obtain percentages. These calculations are used for Tables II and III also.

Source: FAO Trade Yearbook, various issues.

number of currencies involved for a single country's imports complicates the process of adjusting for inflationary impacts on import values. Because agricultural products are not all measured in the same volumetric unit, the variations in commodity composition of imports across countries make it difficult to create an index based on volume. Therefore, nominal figures were used rather than real figures adjusted for the rate of inflation. The purchasing power of the dollar for U.S. consumers in 1989 was $.807 as compared to a 1984 purchasing power of $1.00 (U.S. Department of Commerce). However, all figures are in the same currency, and the focus is on rates of growth so the impact of inflation should not distort the conclusions drawn from these results.

The developed economies as a whole experienced a total agricultural import growth rate of 40.59 percent during the five-year period from 1984 to 1989. Imports to Oceania, Western Europe, and Other Developed Economies (primarily Japan and South Africa and including some islands) grew by more than 50 percent during this time, while imports to North America, Eastern Europe, and the USSR increased at slower rates of less than 15 percent.

The average annual growth rate for the developed economies was 7.19 percent, with negative growth in one period, 1984-85. Individually, Oceania led all developed regions with an average annual growth rate of 10.01 percent and was the only region that showed positive growth in all years measured. Average annual rates fall into two distinct groups. Oceania, Western Europe and Other Developed Economies expanded imports at an average annual rate of over 9 percent. In contrast, North America, Eastern Europe, and the USSR slowly increased imports at rates of less than 3 percent. The USSR experienced the lowest increase at 1.47 percent annually. It is interesting to note, however, that from 1988 to 1989 the USSR showed the second largest increase at 13.05 percent.

The developing economies' total agricultural imports grew by 24.52 percent during the five-year period. The Far East increased imports by 56.91 percent while the second highest growth rate, Other Developing Economies (primarily Oceania and American island nations), was less than half of that at 22.34 percent. The remaining regions all grew by less than 15 percent, with the Near East showing only a 0.82 percent increase.

The average annual growth rate for all developing countries was 5 percent. Negative growth rates during the first two periods were offset somewhat by higher positive rates later, particularly in the last two periods. Imports by the Far East expanded at an average annual rate of 10.27 percent. All other regions in this group had an average annual rate of less than 5 percent. The Near East is the slowest growth region with a rate of 0.75 percent. Most developing regions experienced negative growth during the early periods and much higher positive growth during the later periods.

Growth rates by continent show two distinct groups. Europe had the highest import growth, as measured by both average annual growth rate and total growth rate over the five-year period. The annual rate was 9 percent while the overall growth rate was 52.04 percent. Europe is closely followed by Oceania and Asia. Oceania showed an annual rate of 8.53 percent and a total growth rate of 48.99 percent. Asia's imports increased at an annual rate of 7.46 percent and a total rate of 38.64 percent.

North and Central America, Africa, and South America had significantly lower rates of import growth. North and Central America showed an annual rate of only 3.31 percent with a total growth rate of 17.37 percent. Africa's growth was similar with an annual rate of 2.77 percent and a total growth rate of 12.52 percent. South America is the only continent that had a negative rate of agricultural import growth. The total imports for South America decreased by

10.65 percent during the five-year period measured, and the annual growth rate was -1.41 percent. U.S. agricultural exports to South America decreased by 34.48 percent from 1984 to 1989. The debt crisis of the early and mid-1980s may be partially to blame for these results. An interesting result of the study is that both North and South America exhibited the lowest growth rates among their respective economic groups. These regions have strong historic economic ties and are bound by a common interest in the external debt of Latin America.

Market Size

Table II compares agricultural importers by market size, absolute change in imports, average annual growth rates, and total growth rates from 1984 to 1989. Importers were grouped into five market sizes: all countries, large, medium, small, and very small. Size categories were determined by first ranking all agricultural importers by the value of 1989 total agricultural imports as reported by FAO and then defining natural breaks in the data. The large market size group consists of countries with greater than $5 billion (US$) in agricultural imports and includes 15 countries. The medium market size group of 36 countries had imports of $900 million to $5 billion. The small market size group includes 68 countries with imports of $101 million to $900 million. The very small market size group includes 71 countries with imports up to $101 million. The markets were then ranked within each size category by four characteristics.

The German Federal Republic led all agricultural importers in 1989 with imports of $30.86 billion. Japan and the USA are the second and third largest markets, respectively. Only three continents (Europe, Asia, and North America) are represented in the ten largest import markets, with the concentration of the

TABLE II

COMPARISON OF AGRICULTURAL IMPORTERS BY MARKET SIZE, ABSOLUTE CHANGE IN IMPORTS, AVERAGE ANNUAL GROWTH RATES AND TOTAL GROWTH RATES, 1984-1989

	Rank	All Countries	Total Ag Imports ($100,000)	Large Markets	Total Ag Imports ($100,000)	Medium Markets	Total Ag Imports ($100,000)	Small Markets	Total Ag Imports ($100,000)	Very Small Markets	Total Ag Imports ($100,000)
	1	German Fed Rep	308603	German Fed Rep	308603	Switzerland	40551	Morocco	8022	Sierra Leone	1005
	2	Japan	290595	Japan	290595	Mexico	40164	Bangladesh	7615	Liberia	988
MARKET	3	USA	250658	USA	250658	Saudi Arabia	39944	Hungary	7282	Burk Faso	987
SIZE	4	Italy	218627	Italy	218627	Singapore	31965	Tunisia	7099	Guinea	980
1989	5	USSR	202566	USSR	202566	Algeria	31049	Lebanon	6333	Djibouti	939
	6	United Kingdom	200020	United Kingdom	200020	Sweden	29033	New Zealand	6207	Congo	918
	7	France	198239	France	198239	Denmark	28787	Romania	6065	French Guinea	854
	8	Netherlands	155810	Netherlands	155810	Greece	26076	Sri Lanka	5299	Niger	836
	9	China	110748	China	110748	Iran	25511	Nigeria	5238	Bermuda	775
	10	Belgium-Lux	107980	Belgium-Lux	107980	Iraq	24645	Cote D'Ivoire	5199	Benin	746
	1	Japan	106131	Japan	106131	Mexico	15182	Sri Lanka	2437	Aruba	706
	2	German Fed Rep	103750	German Fed Rep	103750	Switzerland	14121	New Zealand	2298	Sierra Leone	575
ABSOLUTE	3	Italy	89243	Italy	89243	Greece	12840	Tunisia	1825	French Guiana	420
CHANGE IN	4	France	73452	France	73452	Algeria	10405	Cote D'Ivoire	1601	Guinea	388
IMPORTS	5	United Kingdom	64046	United Kingdom	64046	Sweden	10231	Bangladesh	1597	Guyana	311
1984 to 1989	6	China	53381	China	53381	Denmark	9819	Ethiopia	1480	Faeroe Island	270
	7	Netherlands	52812	Netherlands	52812	Austria	9299	Reunion	1445	Albania	248
	8	Belgium-Lux	34557	Belgium-Lux	34557	Turkey	8664	Dominican Rep	1434	Saint Lucia	228
	9	Spain	31359	Spain	31359	Ireland	7321	Angola	1362	Guinea-bissau	197
	10	Korea Rep	28771	Korea Rep	28771	Portugal	7158	Guadeloupe	1154	Cayman Island	181

TABLE II (continued)

	Rank	All Countries	% Change	Large Markets	% Change	Medium Markets	% Change	Small Markets	% Change	Very Small Markets	% Change
AVERAGE ANNUAL GROWTH RATE	1	Laos	60.92	China	15.74	Turkey	21.93	Ethiopia	37.95	Laos	60.92
	2	Cayman Islands	39.11	Korea Rep	13.93	Brazil	16.40	Cameroon	19.23	Cayman Islands	39.11
	3	Ethiopia	37.95	Spain	13.76	Mexico	16.04	Sri Lanka	14.75	Equat Guinea	29.96
	4	Equat Guinea	29.96	Hong Kong	12.50	Thailand	15.72	Martinique	13.96	Guinea-bissau	27.38
	5	Guinea-bissau	27.38	Italy	11.16	Philippines	15.69	Dominican Rep	13.80	Guyana	22.10
	6	Guyana	22.10	Japan	10.17	Greece	15.48	Reunion	12.95	Albania	20.67
	7	Turkey	21.93	France	10.00	Austria	10.57	Angola	11.49	Sierra Leone	20.23
	8	Albania	20.67	Netherlands	9.20	Algeria	10.50	Afghanistan	11.29	Faeroe Island	16.66
	9	Sierra Leone	20.23	German Fed Rep	8.90	Australia	10.04	Korea DP	11.28	French Guiana	15.02
	10	Cameroon	19.23	Belgium-Lux	8.42	Ireland	9.98	Bangladesh	11.02	Cock Islands	14.92
TOTAL GROWTH RATE 1984-1989	1	Cayman Islands	274.24	China	93.05	Turkey	116.08	Ethiopia	126.82	Cayman Islands	274.24
	2	Guinea-bissau	197.00	Spain	85.15	Philippines	100.40	Cameroon	97.71	Guinea-bissau	197.00
	3	Equat Guinea	188.24	Korea Republic	83.85	Greece	97.01	Dominican Rep	89.35	Equat Guinea	188.22
	4	Guyana	143.32	Hong Kong	76.30	Thailand	91.80	Martinique	88.20	Guyana	143.32
	5	Sierra Leone	133.72	Italy	68.98	Austria	62.48	Sri Lanka	85.15	Sierra Leone	133.72
	6	Ethiopia	126.82	France	58.86	Mexico	60.77	Reunion	80.41	Faeroe Island	106.30
	7	Turkey	116.08	Japan	57.53	Ireland	59.27	Korea DP	60.14	Albania	102.90
	8	Faeroe Island	106.30	Netherlands	51.27	Australia	58.64	New Zealand	58.79	Cock Islands	98.18
	9	Albania	102.90	German Fed Rep	50.65	Finland	56.84	New Caledonia	53.85	French Guiana	96.77
	10	Philippines	100.40	United Kingdom	47.10	Sweden	54.41	Haiti	53.72	Guam	89.32

Source: FAO Trade Yearbook, various issues.

largest markets in Europe. It is interesting to note that six of the ten leading import markets are European Economic Community (EEC) members (Belgium and Luxembourg are listed as a single market). Two centrally planned economies, the USSR and China, are among the ten largest import markets.

Japan had the largest absolute change in agricultural imports from 1984 to 1989. The USSR and USA are the only countries which rank among the ten largest markets and do not rank among the ten markets with the largest absolute change in imports. This indicates that the market size in these two countries has been relatively stable over the five-year period. Spain and the Korean Republic, both large markets, experienced substantial increases in imports to move ahead of the USA and USSR in absolute change in market size. Other countries experienced large absolute changes relative to their market size. Mexico, Switzerland, and Greece led medium-sized markets in absolute change. Sri Lanka, New Zealand, and Tunisia had the largest absolute change in imports among small markets. For very small markets, Aruba, Sierra Leone, and French Guinea had the largest absolute changes in agricultural imports.

Market Growth Rates

Laos experienced by far the highest average annual growth rate among importers. However, the figure is distorted by an increase of 386 percent applied to a low base in the one-year period of 1986-1987. Imports actually decreased in the two preceding periods and in the following period. Total agricultural import growth for Laos from 1984 to 1989 was only 29.23 percent.

Turkey is the largest market that ranks among the ten highest average annual growth rate markets. As the market size category increased, the tendency was for both average growth rates and total growth rates to decline. For example, of the ten countries with total growth rates over 100 percent, seven are very small markets, one is a small market, and two are medium-sized markets. The ten very small markets ranking in total growth rate all grew at rates of over 85 percent while only two large markets, China and Spain, increased agricultural imports at rates above 85 percent.

In large markets, China ranks first in both average annual growth rate and total growth rate. The same large markets are listed in the top ten for both measures of growth, with the exception of Belgium-Luxembourg and the United Kingdom. The United States is not listed in either category. Large markets are growing as evidenced by the fact that nine of the largest markets have total growth rates of over 50 percent for the five-year period. These faster growing large markets are located in Asia and Europe. Japan, the U.S.'s largest agricultural export market, grew at an average annual rate of 10.17 percent and at a total rate over the five-year period of 57.53 percent.

Turkey ranks first among medium-sized markets in both average annual growth rate and total growth rate. Agricultural imports by Turkey more than doubled from 1984 to 1989 at a rate of 21.93 percent annually. The ten medium-sized markets with the highest total growth rates all imported at least 50 percent more in 1989 than in 1984. Eight medium-sized markets are listed in both rankings; this is an indication of a steady rate of growth during the five-year period rather than an erratic one. The small markets have seven countries that rank in both measurements of growth. Ethiopia has both the highest annual growth and the highest total growth in this size category. Its annual rate of 37.95 percent almost doubles Cameroon's second highest rate of 19.23 percent. This high growth rate may, in part, result from large amounts of foreign aid received during the food crisis there. Ethiopia and Cameroon are two of the smallest markets in this size classification, yet they lead the group in import growth. The countries listed in the average annual growth rate rankings all experienced average annual rates of over 10 percent.

Several markets in the very small category experienced remarkable growth from 1984 to 1989. The ten fastest growing markets all increased imports at a rate of over 85 percent during the five-year period. The growth rates in this category may be misleading because changes are applied to a low import base. Small changes in imports will result in relatively large growth rates, while total imports remain small. Cayman Islands' agricultural imports grew at an astounding rate of 274.24 percent. Only 18 of the 71 countries in this group had a negative total growth rate. Of those 18 countries, most are on the African continent.

High Volume Import Markets

The 15 largest agricultural import markets include seven countries from the EEC-12 (Belgium and Luxembourg are included as one market). The average U.S. market share for 1989 in these seven countries was only 4.7 percent; however, the growth rate of these combined markets is approximately 10 percent. It is feasible that the U.S. could attain a part of that increase and thus increase its market share. The German Federal Republic is already the largest agricultural import market in the world. With the economic union of the EEC countries, they will become an even larger import market. The inability to adjust for intra-EEC trade flows makes it difficult to determine just how large the joined market will be, but the ramifications of these countries becoming one market make it a vital issue in future U.S. agricultural policy.

Japan is the second largest agricultural import market and is critical to the U.S. because it is our largest agricultural export market. The U.S. market share in Japan is 28.05 percent, but with an average annual growth rate of 10.17 percent there is an opportunity to increase market share further (Table III). The commodity composition of Japanese agricultural imports would be of special interest to the U.S. Product areas where imports are increasing at a faster rate could be specifically targeted in an attempt to capture market share.

The USSR is another large market that could be of major importance to U.S. agriculture. In 1989, the U.S. market share of Soviet imports was 16.29 percent. The average annual import growth rate for 1984 to 1989 was only 1.47 percent; however, the annual average for 1986 to 1989 was 9.33 percent. In the one-year period from 1988 to 1989, USSR agricultural imports increased 13.05 percent. The changing political structure of the USSR will have an impact on future exports to this region. However, if the remaining Union and newly independent countries continue to reduce trade restrictions with the U.S., exports to the region as a whole could greatly increase over time.

Market share figures indicate that Canada, the Korean Republic, and Egypt are major U.S. markets. Canada is a bordering country with which we have a free trade agreement so U.S. market share is expected to be high in that market. In 1989, U.S. market share in Canada was 33.62 percent. Like the U.S., Canada's market is growing at a slow pace with an average annual growth rate of 5.55 percent. The Republic of Korea is another market for agricultural products in which the U.S. has a large market share. The possibility of expanding that market share is greater than in Canada because Korea's annual growth rate is more than twice that of Canada's at 13.93 percent. Egypt is important also with a U.S. share of 19.07 percent in that market. Total U.S.

TABLE III

COMPARISON OF U.S. MARKET SHARE IN 15 LARGEST VERSUS 15 FASTEST GROWING AGRICULTURAL IMPORT MARKETS, 1989

15 Largest Agricultural Import Markets (1989)

Country	Market Size ($100,000)	Avg Annual Growth Rate (percent)	U.S. Market Share (percent)	Total U.S. Exports ($100,000)
German Fed. Rep.*	308603	8.90	2.97	9179.44
Japan	290595	10.17	28.05	81518.83
United States	250658	2.02	N/A	N/A
Italy *	218627	11.16	2.79	6091.85
USSR	202566	1.47	16.29	32988.48
United Kingdom *	200020	8.32	3.68	7362.83
France *	198239	10.00	2.39	4741.10
Netherlands *	155810	9.20	11.85	18467.49
China	110748	15.74	13.10	14961.23
Belgium-Luxembourg*	107980	8.42	0.99	4311.68
Spain*	68185	13.76	12.84	8756.20
Canada	64905	5.55	33.62	21820.02
Korea Republic	63085	13.93	38.89	24532.20
Hong Kong	62933	12.50	9.14	5753.75
Egypt	50050	6.19	19.07	9546.79

15 Fastest Growing Agricultural Import Markets (1989)

Country	Market Size ($100,000)	Avg Annual Growth Rate (percent)	U.S. Market Share (percent)	Total U.S. Exports ($100,000)
Laos	168	60.92	0.00	0
Cayman Islands	247	39.11	63.51	156.88
Ethiopia	2647	37.95	10.87	287.71
Equat. Guinea	98	29.96	0.10	0.10
Guinea-bissau	297	27.38	1.77	5.27
Guyana	528	22.10	21.70	114.60
Turkey	16128	21.93	14.74	2377.70
Albania	489	20.67	0.00	0
Sierra Leone	1005	20.23	8.96	90.09
Cameroon	2070	19.23	4.36	90.16
Faeroe Island	524	16.66	0.00	0
Brazil	19154	16.40	7.77	1488.01
Mexico	40164	16.04	68.80	27633.40
China	110748	15.74	13.10	14961.23
Thailand	12488	15.72	13.52	1688.46

* European Economic Community Members

Source: FAO Trade Yearbook, various issues. FATUS, Fiscal Year 1989 Supplement.

agricultural exports to Egypt are more than those to Hong Kong, which is considered a strong market for U.S. products.

The largest agricultural import markets and the fastest growing markets are two very distinct groups. China is the only country which ranks among the leading 15 countries in both market size and in average annual growth rate (Table III). The average annual growth rate for China over the five-year period was 15.74 percent with total growth of 93.05 percent. The 1989 U.S. market share of agricultural imports by China was 13.10 percent, making it an important export market for U.S. agriculture. As trade with China becomes less constrained, the U.S. may be able to secure a larger portion of the growing market. The U.S. has a market share of 9.14 percent in Hong Kong. Hong Kong is a crucial market because in 1997 it will become part of China. A strong foothold in the Hong Kong market could mean better U.S. access to Chinese markets after the merger takes place.

High Growth Import Markets

The fastest growing agricultural import markets tend to be small or very small countries. Laos is the fastest growing market as measured by average annual growth rate; however, it is also one of the smallest markets in the world. The U.S. has no share of the market in this small country. Turkey, Brazil, Mexico, China, and Thailand are the only large or medium-sized markets among those with high annual average annual growth rates (Table III). The U.S. holds a market share of over 10 percent in each of those countries with the exception of Brazil. The relative market size has a larger bearing on the importance of a market than does market share. For example, the U.S. has a similar market share in the Cayman Islands (63.51 percent) and in Mexico

(68.80 percent). However, total U.S. exports to the Cayman Islands in 1989 were $15.68 million as compared to $2.76 billion to Mexico in the same year. Exports to the Cayman Islands were 0.5 percent of those to Mexico. Although the average annual growth rate of the Cayman Islands is nearly two-and-a-half times that of Mexico, the vast difference in market size makes Mexico a more suitable target for the promotion of U.S. agricultural goods.

Mexico is a valuable market for U.S. products for several reasons. It was the second largest market ranked among the fastest growing markets of the world with an average annual growth of 16.04 percent. The U.S. already holds a substantial market share of 68.80 percent, which makes total U.S. agricultural exports to Mexico higher than to any other country in the high growth rate group. Mexico is a neighboring country to the U.S., so transportation costs have allowed the U.S. to be competitive. If a free trade agreement with Mexico is signed, agricultural exports to Mexico could increase by a considerable amount.

Turkey is a smaller market than Mexico, but its location could make it an important one to the U.S.. Turkey is the gateway from Eastern Europe to the Middle East and is located on the Mediterranean Sea. A large U.S. market share there could influence surrounding countries' choices or expose them to U.S. products, especially processed products. The market is considered medium-sized, but is growing rapidly at an annual rate of 21.93 percent.

Thailand is another medium-sized market that has great potential for increased U.S. exports. It has a high annual growth rate of 15.72 percent along with a market share of 13.52 percent for the U.S. in 1989, which makes it comparable to China, other than in market size.

Conclusions

Developed economies had a higher growth rate for agricultural imports than did developing economies. Over the five-year period from 1984 to 1989, total agricultural imports to developed economies grew at a rate 66 percent faster than imports to developing economies.

South America was the only region with net negative import growth. The debt crisis of the early 1980s contributed to economic decline and, in turn, led to a decrease in agricultural imports. U.S. agricultural exports to this region suffered because of its economic problems.

The largest markets in the world and the fastest growing markets in the world for agricultural imports are two diverse groups. The largest markets tend to be developed economies and grow at a slower rate than smaller markets. Most of the fastest growing markets are small or very small markets in developing economies. China, a large market, is the exception and ranks high in both market size and market growth.

Among large countries, the U.S. holds sizable (over 15 percent) market shares in Japan, USSR, Canada, Korea, and Egypt. In the fastest growing markets, the U.S. has significant market shares in the Cayman Islands, Guyana, and Mexico.

China and Mexico are both important markets for future U.S. agricultural exports. China is a large market with a high growth rate in which the U.S. already holds a 13.10 percent share of agricultural imports. Mexico is a medium-sized market with a high growth rate, and the U.S. currently possesses more than two-thirds of their agricultural-import market.

The former Soviet Union is a market with great potential, given the recent trade discussions among the economic powers. The annual growth rate over the five-year period is very low at 1.47 percent, but over the last three years the annual rate has averaged 9.33 percent. The U.S. has established a substantial market share of 16.29 percent with the USSR and could benefit from more liberal trade practices. Future exports to this region will depend upon the political and economic stability of the recently liberated republics, along with the continued pursuit of trade liberalization with the remaining USSR.

Agricultural import demand is growing worldwide. This growing demand gives the U.S. opportunities to increase market share in several markets while also increasing total agricultural exports. Increased total agricultural exports may help to increase U.S. farm income, decrease the U.S. trade deficit, and justify large expenditures on export promotion programs.

Organization of the Study

A brief outline of the study follows. Chapter II is a review of the literature presenting estimations of single and multiple commodity import demand functions and of export demand functions. Chapter III presents a discussion of the economic theory underlying import demand and of demand elasticities. Chapter IV introduces the models and data used in the empirical estimations of import demand for agricultural products in twelve of the world's fifteen largest agricultural import markets. Chapter V presents the results obtained through the empirical estimations of agricultural import demand in those markets as a whole and in groups of countries classified by average annual growth rates of imports. Chapter VI concludes the study.

CHAPTER II

LITERATURE REVIEW

Varying growth rates of demand for agricultural imports may be explained by such factors as the elasticity of import demand with respect to population, income, or prices. Therefore, the emphasis of the literature review is on models which empirically estimate import demand.

Previous studies that focus on import demand can be categorized as either multiple product (including total import demand) or single commodity models. Export demand models may also provide insight on the relevance of certain variables used to estimate import demand. Chapter II reviews the models presented in existing literature for these three categories.

Multiple Product Import Demand Models

Boylan, Cuddy, and O'Muircheartaigh (1979) presented a method of choosing the appropriate functional form for estimating import demand functions. They note that using a given functional form always implies specific theoretical restrictions, and misspecification of the functional form will lead to biased and inconsistent results. The results of the study are then compared to those of a study by Khan and Ross (1977) in which a Box-Cox procedure was used to determine that the log-linear functional form was more appropriate than the linear form for the United States, Canada, and Japan.

Import demand equations were estimated for Ireland, Denmark, and Belgium using annual data from 1953 through 1975. The economic development stage and structure were important characteristics considered in choosing these countries; the development category in which they fall distinguishes them from the group used in Khan and Ross's study. A simplified import demand equation was used to emphasize the importance of the functional form in this study, rather than the variables in the equation. The quantity of imports demanded is the dependent variable in the generalized model, while the price ratio of imports to the domestic price level and real gross national product are the independent variables. A model specification variable was incorporated into each independent variable to measure the appropriateness of linear versus log-linear specifications. Results indicated that the log-linear import demand equation was more appropriate that the linear form in the three countries studied.

The results of Boylan, et al, support the use of the log-linear functional form of aggregate import demand equations in three countries with a different level of economic development than those used in Khan and Ross (1977). This gives increased validity to the generalization of Khan and Ross that these results hold across different levels of economic and structural development as mentioned in their paper.

Khan and Ross (1975) estimated an import demand equation that attempts to separate demand into cyclical and secular components. Traditional import demand equations consider imports dependent upon income and relative prices. Khan and Ross modify the traditional demand equation to include both a secular and a cyclical demand into two parts is that the traditional import demand equation results in an estimate of cyclical income elasticity, which could distort projections of future import quantities.

The model developed here considers the deviation of actual import demand from potential import demand. Semi-annual observations from 1960 to 1972 were used for fourteen industrial countries. The traditional model assumes that "importers are always on their demand curve so that the demand always equals the actual level of imports" (Khan and Ross, p. 358). Khan and Ross estimate "potential" import demand using trend levels of real income. Then the deviation of actual import quantities from potential import quantities is measured. The final estimation equation incorporates both concepts into the import demand equation,

$$\log M_{it}^{d} = b_0 + b_1 \log P_{it} + a \log Y_{it} + (b_2 - a) \log Y^{*}_{it} + E_t \qquad (2.1)$$

where:

M_{it}^{d} = quantity of imports demanded by country i in year t

P_{it} = unit-value of the imports of country i deflated by the domestic price level in year t

Y_{it} = real income of country i in year t

Y^{*}_{it} = potential real income of country i in year t.

This equation holds the assumption that actual imports equal the demand for imports and that there is no adjustment lag.

The parameter for potential real income gives the estimate for the potential real income elasticity. This variable was significant in 6 of the 14 countries studied. The United States and United Kingdom had positive and significant potential real income elasticities while Canada, France, Japan, and Switzerland had negative and significant potential real income elasticities.

Warner and Kreinin (1983) assessed the effect of variations in the exchange rate and the effect of expected exchange rate variations on trade flows. They estimated import and export demand functions for 19 industrial countries. An interesting characteristic of this study is its inclusion of fixed and flexible exchange rate eras, thus making a comparison of systems possible.

The model estimated equations for import and export demand in each country using data from 1957 to 1980. Data was grouped into the fixed exchange rate period (1957-1970) and the flexible exchange rate period (1970-1980). Equations were estimated for all products; however, in the second period, import demand was estimated all products and then for "non-petroleum" products. Two equations are estimated for import demand; one equation uses a price ratio variable while the other equation specifies domestic and import prices separately. This is to test the validity of the homogeneity assumption associated with using a price ratio variable. The basic import demand equation in this study is:

$$\ln M = C + a_1 \ln Y + a_2 \ln PM/PD \qquad (2.2)$$

where M = Total Imports

C = Constant

Y = Income

PM = Import Prices

PD = Domestic Prices.

Additional variables added in the second period included:

E(-1) = Lagged Exchange Rate Variable

E(P) = Expected Exchange Rate Changes

The authors included a foreign reserves variable in initial equations, but it was excluded from the final equation because it did not prove to be significant.

Warner and Kreinin contend that exchange rates and export prices are powerful determinants of a country's exports. The price variable yielded more accurate results when separated into domestic price, import price in foreign currency, and the exchange rate (Warner and Kreinin, p. 103). In most countries, the time lag for exchange rate changes, domestic price variables and import price variables was bell-shaped peaking at a one or two quarter lag. In some importing countries, anticipated changes in the exchange rate also had a significant impact on current imports. These authors found that exchange rate changes impacted export demand more than import demand in most countries.

Arnade and Dixit (1989) tested for the presence of money illusion in import demand. Their argument is that the assumption of homogeneity of degree zero in prices and income may not be appropriate for the international trade model. Reasons given in support of this argument include: (1) there is imperfect knowledge of the Consumer Price Index (CPI), (2) demand is a function of not only income, but wealth as well, (3) trade rigidities exist which delay responses to price changes, (4) the CPI gives significant weight to non-traded goods, and (5) the aggregation of domestic demand and supply functions does not imply zero homogeneity. The inappropriate assumption of zero degree homogeneity will result in biased elasticity estimates and communicates incorrect information to policy makers.

Inflation is a major concern because it provides a link between the agricultural and non-agricultural sectors of the economy. It also links the domestic economy with other economies of the world through relative inflation rates. If the degree of homogeneity is equal to zero, inflationary prices will be matched by equal increases in income, thus imports will be unaffected. However, if homogeneity is not equal to zero, price increases and income increases will not be equal; therefore, imports will be affected. Also, import demand is typically estimated using real rather than nominal variables. If money illusion is present and importers have imperfect knowledge about prices, then this specification with real variables may not reflect an accurate estimate of purchasing behavior. Perhaps nominal prices would better reflect the importers' behavior with respect to purchasing agricultural products.

Arnade and Dixit test for the presence of money illusion in import demand by testing for the effect of imposed zero homogeneity in several import demand equations. They also test for the correct price and income deflators. The model assumes that excess domestic demand is the equivalent of import demand. The basic model for estimating import demand in this study is:

$$IM = X_1\ (P_1/CPI,\ P_2/CPI,\ Y/CPI) - S_1\ (P_1/CPI \ldots W_1/CPI) \qquad (2.3)$$

where:

X_1 = domestic demand

P_1 = nominal price of good one

P_2 = nominal price of good two

Y = nominal income

CPI= Consumer Price Index

W_i = ith input nominal price.

The demand function represents utility maximizing consumers while the supply function represents profit maximizing producers. Import demand functions with and without homogeneity restrictions were estimated for wheat and soybeans in five countries with a variance from 226 percent to 1 percent in inflation rates. The equations are estimated in double log form so the parameters are elasticity estimates.

The equations estimated without the CPI have poorer fits than those equations estimated with the CPI. The study suggests that if zero homogeneity is imposed, then the CPI should be included. The main conclusion of the study is that imposed zero homogeneity restrictions may distort the true nature of the relationships between quantity imported and the price and income information available.

Melo and Vogt (1984) developed an import demand model in an effort to estimate income and price elasticities for Venezuelan imports and to relate the results to the economic development of the Venezuelan economy.

The double-log import demand model estimated is:

$$\text{Log } M^d_{it} = a_{0i} + a_{1i}\log(PM_i/PD_i)_t + a_{2i}\log Y_t + a_{3i}\, D_{it} + u_{it} \tag{2.4}$$

where:

M^d_i = quantity demand of the ith import commodity;

PM_i = price of the commodity;

PD_i = price of the domestic substitute;

Y = real gross domestic product;

D_i = dummy variable as proxy for increase in permanent income;

u_i = random disturbance;

a_{1i} = relative price elasticity of demand for commodity i;

a_{2i} = real income elasticity.

The data used in this study is disaggregated annual data from 1962 to 1979. The equation is estimated for total imports, then for tobacco and beverages, chemicals, machinery and transportation equipment, and food individually.

Melo and Vogt found greater price and income elasticities than previous studies. They suggest that the greater price elasticity indicates that domestic industries which produce importable goods have increased while the greater income elasticity indicates an increase in the openness of the economy.

Arize and Afifi (1987) focused on estimating import demand in developing countries. Prior to this study, empirical studies on aggregate import demand behavior generally concentrated on developed countries (Arize, et al). These authors measure price responsiveness and stability of import demand in thirty developing countries.

The model used encompasses the traditional aggregate import demand equation relating import quantities to price and income variables. Four log-linear equations, including two equilibrium and two disequilibrium equations, are estimated for each country:

(1) $M_{it} = M_{it}\ (TY_{it}, CY_{it}, Pm_{it}, Pd_{it})$ (2.5a)

(2) $M_{it} = M_{it}\ (TY_{it}, CY_{it}, Pm_{it}, Pd_{it}, M_{it-1})$ (2.5b)

(3) $M_{it} = M_{it}\ (TY_{it}, CY_{it}, P_{it})$ (2.5c)

(4) $M_{it} = M_{it}\ (TY_{it}, CY_{it}, P_{it}, M_{it-1})$ (2.5d)

where

M_i is the real quantity of imports of country i;

P_i is the ratio of the unit value of imports (P_m) of country i to the domestic price level (P_d) of country i;

Y_i is the real gross domestic product of country i;

TY_i is trend level of real income; and

CY_i is the ratio of current real income (Y) to the trend value (Arize, et al).

The equilibrium equations assume that imports adjust quickly to changes in independent variables; consequently the market is generally in equilibrium. The disequilibrium equations include a lagged dependent variable to capture the delayed response of import quantities to changes in the independent variables and assume that the market is always in disequilibrium because of the adjustment period. The two stage least square (TSLS) method was used to estimate the equilibrium equations while the Sargan two-stage least squares (STSLS) method was used in estimating the disequilibrium equations. Criteria used to choose the appropriate model for a particular country included (1) excluding statistically unstable equations, (2) signs and significance of independent variables, and (3) R^2 values.

The long-run estimated own-price elasticity is negative as expected and greater than or equal to 1 in absolute value for most of the countries studied. This suggests a large response of import quantities to changes in import or relative prices. However, consumers respond more to changes in domestic prices than to import price changes of the same magnitude. Equilibrium equations were estimated for 17 of the 30 countries studied, indicating that import volume adjustment occurs more quickly than argued by previous studies.

Single Commodity Import Demand Models

Shalaby, Yanagida, and Hassler estimated market share elasticities for U.S. wheat in Latin American countries for policy analysis purposes. The U.S. share of wheat imports to Latin America averaged 41 percent from 1966 to 1985. The all-time high U.S. market share occurred in 1981-1982 at 48 percent, but in 1984-1985 had declined to only 37 percent. Shalaby, et al, cite three reasons for this decline: (1) changes in international economic relations (exchange rates, trade agreements), (2) changes in the U.S. domestic economy (interest rates, inflation, government spending), and (3) changes in the domestic agricultural program (prices, support policies).

An equation was estimated for each of the eight Latin American countries included in the study using annual data from 1962 to 1981. Seemingly Unrelated Regression (SUR) was used to estimated the equation set. The study included eight Latin American countries where the U.S. has been the dominant exporter of wheat. The model used to estimate market share was:

$$\text{Ln } S_t = D_0 + D_1 \text{Ln}S_{t-1} + D_2(\text{Ln}R_t + \text{Ln}R_{t-1}) + E_t \qquad (2.6)$$

where:

S_t = U.S. market share in current period;

S_{t-1} = U.S. market share in preceding period;

R_t = percentage of U.S. border price of wheat to the world border price of wheat for the importing country in current period;

R_{t-1} = percentage of U.S. border price of wheat to the world border price of wheat for the importing country in preceding period;

e_t = random error term.

"Wheat is defined as commercial wheat and wheat flour in wheat equivalent," (Shalaby, et al, p. 3). A two-year moving average was used for the price ratio.

The results of the study indicate that long-run market shares are more elastic than short-run market shares. Decreased world wheat prices and a weaker U.S. dollar should have a positive impact on the U.S. market share of wheat imported by increasing the purchasing power of these countries. U.S. export subsidies should be implemented cautiously and should be targeted at countries where they can have the greatest impact on U.S. wheat exports based on estimated price elasticities.

Leong and Elterich (1985) constructed a model to analyze the Japanese import market for U.S. broilers. First, they developed a model of the Japanese broiler market; then they constructed models to measure per capita demand of broilers in the Japanese market and import demand for U.S. broilers.

Monthly data is used from January 1974 to February 1982. By using monthly data, the seasonality of per capita demand and of import demand from the U.S. is accounted for. The import demand model is as follows:

$$\begin{aligned} LNMUS = {} & LNa - b_1 LN(1/RPUSB_{t-1}) + b_2 LN(1/RWPP_{t-1}) + \\ & b_3 LN(1/RWBEEF_{t-1}) - b_4 LN(1/XR_{t-1}) + b_5 LN(1/PCGNP_{t-1}) - \\ & b_6 LN(1/JPC_{t-1}) + D_1 \ldots D_{11} + CDM_2 + DPCGNP + LNu_3 \end{aligned} \tag{2.7}$$

where:

MUS	=	Japanese import of broilers from the U.S., in metric tons;
RPUSB	=	Wholesale price of U.S. broilers, nine-city average, deflated by the U.S. wholesale price index, in cents/kg;
RWPP	=	Wholesale price of pork in Japan, deflated by the Japanese WPI, in yen/kg;
RWBEEF	=	Wholesale price of beef in Japan, deflated by the Japanese WPI, in yen/kg;
XR	=	Exchange rate ratio, in yen/U.S. dollar;
PCGNP	=	Per capita GNP;
JPC	=	Japanese domestic production of broilers, in metric tons;
CDM_2	=	Constant dummy;
DPCGNP	=	Slope dummy for variable PCGNP; and
U_3	=	Disturbance term.

The equation is estimated using the Two Stage Least Squares method because of the inclusion of the endogenous variable, Japanese Broiler Domestic Production, on the right side of the equation. Double-log form is used in order to easily obtain elasticity measures. All variables are lagged one month with the exception of the dummy variables. "This is to take into account the time delay between the decision to purchase and the actual physical arrival of the goods" (Leong and Elterich, p. 11).

Leong and Elterich's results indicate that Japanese import demand for U.S. broilers is highly income elastic; however, they also point out that this elasticity is applied to a small quantity base. The price elasticity of pork as a substitute good was higher than that of beef or own-price elasticities. Shock-simulations suggest that "a drop in the exchange rate-i.e. a strengthening of the yen-increases the import demand for American broilers much more than a comparable increase in the exchange rate would decrease import demand" (Leong and Elterich, p. 31). Policy suggestions for the U.S. include maintaining low wholesale prices for broilers to hold or increase competitiveness with increased domestic broiler production in Japan, as well as considering the development of a preferential yen-to-dollar rate for broiler trade.

Ortalo-Magne and Goodwin (1990) examined the international wheat gluten market and estimate the U.S. import demand for wheat gluten. Wheat gluten is "mostly utilized in the milling and baking sector (approximately 75 percent of wheat gluten end-usage), where gluten is a protein complement in flour and other wheat products" (Ortalo-Magne and Goodwin, p. 3). The market for wheat gluten is a small, specialty market in which there is no substitute product.

U.S. import demand for wheat gluten is modelled as follows:

$$ID_t = f(ID^d{}_{t-1}, P_t, P^c{}_t, Y_t, Z_t, X_t) \tag{2.8}$$

where:

- ID = quantity of wheat gluten imported by the U.S.;
- P_t = price of wheat gluten;
- $P^c{}_t$ = price of complements (CPI for flour);
- Y_t = income measure;
- Z_t = exogenous demand shifters (protein amount of the national wheat harvest); and
- X_t = exogenous supply shifters.

The data set consisted of monthly observations from 1974 through 1987. The Box-Cox flexible functional form was used to estimate the above equation.

Import demand for wheat gluten in the U.S. seems to be very inelastic with respect to price. Short-run and long-run elasticities are nearly equal, indicating a quick adjustment lag. Import demand response to income is inelastic, while the response to the protein content of domestic wheat is very elastic. Ortalo-Magne and Goodwin suggest that because the U.S. import demand for wheat gluten is not price-elastic, export subsidies by exporters will not greatly impact the export quantity demanded by U.S. purchasers.

Islam (1978) developed an import demand model with foreign reserves as a variable and determined the significance related to government interference in markets. The study focuses on the dependence of rice imports in several Asian countries upon the availability of foreign reserves.

The model uses rice imports as the dependent variable with foreign reserves, price, income, and domestic production as the independent variables. Islam makes two important assumptions: (1) actual production is assumed to independent of foreign reserves and (2) foreign reserves affect rice imports only through their influence on consumption. Ordinary Least Squares (OLS) was used to estimate the equation using annual data from 1953 through 1972.

Islam found that rice imports in all but two of the countries studied had foreign reserve elasticities greater than one. High income elasticities with respect to rice imports were also determined. The combination of these two elasticities suggests that imports are affected in two ways. First, if a country's exports increase, then its per capita income increases. An increase in income will in turn create higher imports. Second, increased exports implies increased foreign reserves, which in turn induces increased imports (Islam, p. 534). The implications from these findings are that bilateral trade agreements between rice-surplus and rice-deficit countries would be beneficial to both sides. When rice-surplus countries purchase non-rice products from rice-deficit countries, the income and foreign reserve level increases for rice-deficit countries. Therefore, rice-deficit countries are able to purchase a larger volume of rice from rice-surplus countries, thus increasing exports.

Ito, Chen, and Peterson (1990) suggested modifications of the Armington procedure for agricultural trade analysis. They argue that the original Armington model has several limitations that, if modified, could more accurately predict agricultural trade flows. Domestic production, which may have a large impact on import demand, is not specifically included in the model. The model also assumes constant elasticity of substitution, which may or may not be true. Homothetic shares for individual exporters are assumed; this negates the idea that importers' preferences may determine exporters' shares. Ito, et al, make several suggestions to improve the Armington model. If market shares rather than quantities are used in the estimation, the problem of constant elasticity shares may be avoided because domestic production is allowed to fluctuate. Other studies have found that quantity dependent price variables are insignificant while share dependent price variables are significant (Ito, et al). Ito, et al, modified the original Armington model and then tested the significance of the original versus the modified version. The modifications included inserting an equation in the first stage to explain total import demand rather than total demand as estimated by the original equation. In the second stage, a market share equation, a budget, and an importer preferences variable were added. The validity of using pooled data was tested by comparing the price coefficients from the pooled regression with the price coefficients from the individual exporters' equations. The coefficients were statistically different and correlation errors were observed. Quantity-dependent and market share dependent equations were compared under the single constant elasticity of substitution assumption; R^2 values suggested that the market share equation was superior to the quantity dependent equation (Ito, et al). Market share dependent equations were used to test the assumptions of single constant elasticity of substitution and homotheticity. These assumptions were found to be inappropriate for the rice market in Asian countries. The modified approach suggests that importers are sensitive to relative prices. The import market for rice is thin so importers can choose from several suppliers. Importers can be discriminative about price and quality of exporters' products.

Developing countries represent 60 percent of the U.S. wheat export market; therefore, their wheat import demand elasticities are of great importance to U.S. producers and policy makers. Jabara (1982) estimates a reduced-form import demand model for wheat in 19 middle-income developing countries (MIDC's) using data from 1976 to 1979. "Pooling of time-series and cross-sectional data assumes that structural coefficients are the same across countries" (Jabara, p. 1). The Generalized Least Squares (GLS) method was used to allow for different country-specific intercepts. Short-run elasticities are obtained from the model which represent the average for the sample countries (Jabara, p. 1). Jabara states that as long as no structural differences exist between countries, the estimates may be more reliable than estimates from individual countries because of the short time period used.

The model developed in the study is:

$$WM_{it} = A + B_1\ POP_{it} + B_2\ IMC_{it} + B_3\ WST_{it-1} + B_4\ P_{mit} + B_5\ WP_{it} + B_6\ PRODW_{it} + B_7\ FAID_{it} + E_{it} \qquad (2.9)$$

where:

WM_i = total concessional and commercial wheat imports by country i, 1000 metric tons;

POP_i = population in country i, millions of persons;

IMC_i = real foreign exchange availability in country i, millions of 1975 U.S. dollars;

WST_i = carrying wheat stocks in country i, 1000 metric tons;

Pm_i = consumer price of wheat in country i (resale price to mills or wheat equivalent price of bread or wheat in flour), deflated by the consumer price index in country i, in 1975 U.S. dollars per metric ton;

WP_i = world price of wheat in country i, deflated by the consumer price index in country i, 1975 U.S. dollars per metric ton;

$PRODW_i$ = production of wheat in country i, 1000 metric tons;

$FAID_i$ = concessional wheat shipments to country i, 1000 metric tons; and

E_i = a random error term.

Countries were designated as either wheat-producing or nonwheat-producing and separate regressions were run for each group.

Results indicate that non-wheat producing countries respond to changes in world prices while wheat producing countries do not respond to those changes. In general, MIDC's have a low response to changes in world price, foreign exchange, and quantity. Production is fixed in the short-run; therefore, the calculated price elasticities do not represent responses to changes in production. The low elasticities for wheat import demand imply that the short-run elasticities for U.S. wheat export demand is low, also.

Abbott (1979) addressed the problem of government interference in international grain markets. Traditionally, trade estimations have been made using a standard domestic supply and domestic demand model. Such models assume free trade and market efficiency in international agricultural trade. He argues that a modified approach endogenizing government actions is needed because governments often implement domestic price insulating policies. Those policies cause variations in import demand to be less than variations in production (Abbott); also, small traders may face a foreign exchange constraint that is frequently ignored.

The following variables were included in Abbott's model:

XT	= Net Imports of Commodity x in Country i
XP	= Production
XC	= Consumption
XQ	= Domestic Supply to Trading Market
XS	= Stocks on Hand
XR	= Net Stocks Released
XA	= Aid in Kind Received
PW	= World Market Price of Commodity x
PP	= Producer Price of Commodity x
PD	= Consumer Price of Commodity x
PI	= Price Index for Inputs Used by Farmers
POP	= Population
INC	= National Income at Constant Prices
FX	= Foreign Exchange Flows (Total Exports plus Foreign Capital Inflows)
AN	= Stock of Animals (in relative feed units)
EX	= Expenditure on Commodity x (in \$ millions)
T	= Time Trend

Abbott estimated a net import demand model for wheat and feed grains in 33 countries using annual data from 1951 to 1973. The variables included in the model emphasize the relationship between international and domestic prices. A foreign exchange constraint is also included because foreign exchange reserves affect a country's ability to purchase imports. Foreign aid is also included, but Abbott argues that it may only partially create demand. It may actually be only an increase in supply if distributed through government or import channels.

This research suggested that a stable domestic price is a popular policy in many countries. In general, countries are not flexible in changing domestic agricultural policies in response to world market fluctuations. Stocks are often used instead to partially control domestic prices in response to changing border prices. Foreign exchange availability also has a large impact on import volume. The study supported Abbott's proposed idea that standard methods of estimating short-run trade flows should be modified to reflect inflexibility in government policies toward domestic prices. This invalidates the assumption that international agricultural markets are efficient and that a one to one correspondence between trade and domestic production exists. Price and policy inflexibility will cause variations in import demand to be less than the variations in production.

Export Demand Models

Pick (1990) modelled the influence of exchange rate risk on bilateral agricultural trade flows between the U.S. and the selected countries. The countries included were Japan, South Korea, Canada, Australia, West Germany, France, Netherlands, United Kingdom, Brazil, and Mexico. These ten countries comprise the market for over one half of U.S. agricultural exports. His model assumed that import demand is a derived demand where imports are used in the domestic production of the final good. The importer is risk-averse and maximizes expected utility with respect to profits (Pick, pg. 694). The model discerns between imports denominated in foreign and domestic currency and between hedged and unhedged transactions, as both of these conditions have a bearing on the degree of exchange rate risk.

Ordinary Least Squares (OLS) regression was used to estimate the double-log equation. The dependent variable in the empirical model is real export value. Independent variables included are importer's real income, importer's real unit production cost, exporter's real unit production cost, foreign currency per U.S. dollar exchange rate, a four-quarter moving-average of recent percentage change in the bilateral exchange rate, and a risk measure to account for the uncertain growth rate of the real exchange rate (Pick, p. 695). Two different risk measurements are used in separate regressions. The first is based on quarterly standard deviations from the relative change in the real exchange rate; the second is based on monthly standard deviations. Quarterly data from 1978-1987 are used in the analysis.

Pick concluded that as the dollar appreciates in real terms, agricultural imports decrease. Several of the countries studied have high income elasticities with respect to agricultural trade. As domestic production costs increased, imports increased; as U.S. production costs increased, imports tended to decrease. Increased exchange rate risk had a negative effect on the volume of agricultural trade.

Agricultural imports by developing countries were more affected by exchange rate risk than agricultural imports by developed countries. Pick notes that developing countries have underdeveloped financial markets, thus hindering hedging of foreign exchange on trade contracts. Trade in these countries is more restricted and centralized which the author contends makes them more susceptible to exchange rate risk. The conclusions of this study suggest that the real foreign exchange rate is significant in determining U.S. agricultural exports, but exchange rate risk is significant only in certain markets.

Chambers and Just (1981) estimated U.S. export demand in order to examine the dynamic effects of exchange rate fluctuations on U.S. commodity markets. The effects of exchange rate changes reach not only price and exports as most studies have concentrated on, but also domestic disappearance and inventory accumulation. This study attempts to model those effects on the total adjustment process with respect to domestic and foreign components of agriculture.

The model used by Chambers and Just was estimated for corn, wheat, and soybeans as a single system using three-stage least squares (3SLS). The model was aggregated to focus "on the net effects of exchange rate fluctuation in each of the markets rather than on each particular component of the market" (Chambers and Just, p. 37). Quarterly data from 1969 (I) to 1977 (II) was used. The model included equations for disappearance, inventory, exports, production, and identities for each commodity. Linear relationships between variables were assumed; therefore, the equations were estimated in per capita form to preserve linearity. The authors used an indicator variable to account for seasonal effects in each equation.

The results of the study indicate that the three largest export commodities of U.S. agriculture (wheat, corn, and soybeans) are very sensitive to exchange rate movements. In the short run, the adjustments to changes were dramatic; in the long run the adjustments were less dramatic, but significant. Their findings support the elasticity approach, especially in the short run. This study points out the uniqueness of the agricultural sector in its production practices and emphasizes that its rigidity slows the sector's production response to exchange rate changes. Exchange rate changes have dynamic effects on agriculture and alter the relative split between exports and domestic use in each of the commodities studied (Chambers and Just).

Bredahl, Meyers, and Collins (1979) emphasized the importance of price transmission elasticities in estimating foreign demand elasticity. In many instances, price transmission elasticity is assumed to be one, implying that the foreign import price of a commodity is equal to the world price. This assumption will result in an overestimation of export demand elasticities when governments practice price insulation policies or when transportation costs are added to the import price.

Many U.S. export markets insulate domestic markets from the U.S./world price. A heavily insulated economy will have a price transmission elasticity that approaches zero. This study breaks U.S. export markets into importing and exporting regions; then the implied price transmission elasticity for the region is decided by reviewing the region's trade policies with respect to domestic prices. Centrally planned economies have an implied price transmission elasticity of zero, while free trade economies have an implied price transmission elasticity of one.

Bredahl, Meyers, and Collins used these implied price transmission elasticities to estimate export demand elasticities for the U.S. in major commodities. Based on the assumption that each region will contribute to the elasticity of demand for U.S. agricultural exports, regional elasticities were weighted by import shares from the U.S. and then summed to obtain the total elasticity of U.S. export demand. Their estimates were significantly lower than those of previous studies which assumed a price transmission elasticity of one.

Dutton and Grennes (1987) analyzed the use of different indices of multilateral exchange rates for agricultural trade. The measurement of exchange rate changes is critical to models of agricultural trade because it affects the interpretation and estimation on trade models (Dutton, et al, p. 428).

Many indices exist which measure exchange rate changes with varying methods. Some were formulated specifically for agricultural trade while others were formulated for total trade. Dutton and Grennes suggest that if agricultural exports are the focus of the model, then an index formulated from agricultural trade partners' exchange rates rather than from all trade partners is more suitable. An important characteristic of an index is the number of countries and currencies included. Different base periods as well as various mathematical approaches are used in calculating indices. Each of these factors has a large impact on the effectiveness of the index for a particular analysis and decisions regarding them should be made with great care. Several exchange rate indices are compared during the time period of 1970 to 1985 to illustrate the variation among measurements.

Gardiner and Carter (1988) reviewed issues concerning elasticities in international agricultural trade. Price elasticities are the focus of much of the discussion. Elasticities are used to test theories, to explain market structures, to forecast trade flows, and to analyze policies (p. 1). An example of the importance of elasticities in international trade theory is the Marshall-Lerner Condition. It states that a currency depreciation will improve a country's trade balance if the absolute value of the sum of its import demand and the demand for its exports is greater than one.

Forecasting models depend upon elasticities to predict market shares, prices, and future imports and exports. Policy decisions are often based on similar models used to predict the effect of trade barriers and incentives on trade variables such as price and quantities.

Many international trade research studies have focused on price elasticities. The importance of price elasticities, especially in the United States, has been emphasized by the boom and bust of agriculture in the 1970's and 1980's. The effectiveness of U.S. farm policy depends on the elasticities of the demand for our exports, which may vary by commodity. Whether trade remains restricted or becomes more liberalized, price elasticities will be of great importance in the future.

Gardiner and Carter state that the appropriate model for estimated elasticities in international trade depends upon four factors: (1) the model's purpose, (2) the nature of the commodity under investigation, (3) the type of market that the commodity is traded in, and (4) the desired degree of regional disaggregation (Gardiner and Carter, p. 4).

The perfect substitutes model of international trade treats imports and exports as excess functions of the domestic supply and demand functions. Trade elasticities are then obtained by combining the domestic supply and demand elasticities with information on the level of imports and exports and domestic production and consumption (Gardiner and Carter, p. 5). The imperfect substitutes model of international trade has separate functions for imports and exports. Elasticities are taken directly from the parameter estimates in each function.

The importance of selecting the correct variables to include in the chosen model is stressed by Gardiner and Carter. The price variable is particularly important because of the various indices available. Each index contains different information about commodity and country aggregation. The appropriate index should imply the correct price response and substitution relationships. Using an incorrect index can result in incorrect elasticity estimates.

The Armington model was developed to help alleviate some of the estimation problems which occurred in international trade. Two stages are used to predict the level of imports, allowing the cross-price elasticities to be calculated between all exporters from estimates of the aggregate price elasticity for imports, the elasticity of substitution, and trade shares (Gardiner and Carter, p. 6). The "almost ideal demand system" was used to test the assumptions of the Armington model because its assumptions were considered simplistic and restrictive by some. Using this model, the assumptions of homotheticity and separability are rejected. However, the Armington framework continues to be a popular approach to estimating international trade. Other decisions to be made with regard to price elasticities are (1) how to account for time lags associated with quantity response to price changes and (2) how to handle exchange rates within the equation.

There are many common problems when estimating trade equations. Simultaneity between prices and the error term can be a problem that will contribute to biased estimates. The environmental factors in agriculture may cause production shifts that imply changes in excess demand functions (Gardiner and Carter, p. 8). Another issue is whether the aggregation of countries and commodities in equations results in accurate price elasticity estimates. Also, foreign and domestic trade policies should be considered when estimating elasticities. Policies may insulate domestic consumers and/or producers from price changes in the world market.

Kim and Lin (1990) developed an export-side international trade model and applied it to the world wheat market in an attempt to measure trade liberalization impacts on trade flows. Producer Subsidy Equivalents (PSE) and Consumer Subsidy Equivalents (CSE) were used as measurements of trade barriers in developing an Export-Side International Trade model, recognizing that other barriers exist which inhibit trade among countries. The export demand intercept is modelled as a function of the slope of the export demand function, excess demand, elasticity of supply, producer export price, price transmission elasticity, export demand elasticity, Producer Subsidy Equivalent, and Consumer Subsidy Equivalent. The horizontal export demand shifts are then measured for major grain-trading countries such as the United States, Japan, Canada and the European Community by excluding PSE's and CSE's from the model.

The Armington model assumes that the importer will maximize utility subject to a total budget to determine commodity composition; then the importer will maximize utility subject to the budget allocation per commodity to determine trading partners. Importing countries consider commodities from different countries as imperfect substitutes for each other. A constant substitution elasticity is assumed for each product pair. The Export Side International Trade Model approaches export demand in a different way. The domestic commodity market is linked to the international commodity market through domestic commodity demand or supply. A shift in the domestic demand or supply curve results in an equal shift in the respective international market curves. The international commodity market is then linked to domestic export markets by aggregating excess demand in the international market and then subtracting all other exporters' excess supply from the aggregated excess demand to obtain the export demand curve for a specific country. In contrast to the Armington procedure, equilibrium is quantity determined rather than price determined. The market is cleared "at the point where the excess supply curve intersects the export demand curve in each export market" (Kim and Lin, p. 11). The results of this study indicate that, in the short run, government wheat subsidy expenditures and other domestic policies "generate little benefit at great cost and that the payoff on trade liberalization could be significant" (Kim and Lin, p. 10).

Konandreas, Bushnell, and Green (1978) estimated export demand for U.S. wheat for five different world regions in order to obtain price and exchange rate elasticities. Because the demand for U.S. wheat exports is the sum of the demand for U.S. wheat in importing countries, factors that affect import demand in those countries must be considered when modeling U.S. export demand.

U.S. wheat export demand is modeled in this study as follows:

$$M_t = b_o + b_1Q_t + b_2PE_t + b_3YE_t + b_4C_t + b_5M_{t-1} + u_t \qquad (2.10)$$

where

Q_t = per capita wheat production in the region;

C_t = U.S. concessional wheat exports to the region;

PE_t = (SUM)k to k_j $(W^k)(PE_t^k)$; the "effective" U.S export price in that region;

PE_t^k = $P_tUS/(P_t^k/ER_t^k)$ which is the "effective" U.S. export price of wheat in the kth country, expressed as the U.S. export price over the domestic price in the kth currency (expressed in U.S. currency);

YE_t^k = Y_t^k/ER_t^k which is the "effective" per capita real income of kth country expressed in U.S. currency;

YE_t = (SUM) k to k_j $(W^k)(YE_t^k)$ which is the "effective" per capita real income of that region; and

w^k = kth country's average regional import share of U.S. wheat.

The equations were estimated with the Ordinary Least Squares and Conditional Least Squares methods using data from 1954 to 1972.

Konandreas, et al, found that in the developed countries and in Latin America and Africa, domestic wheat production had a negative impact on U.S.

wheat exports, as expected. However, in the other two regions, Asia and U.S.S.R./Eastern Europe, domestic production had a positive impact on U.S. wheat exports. The authors contribute this finding to the fact that this study is only a partial analysis of the world wheat market and does not consider wheat supplies from other exporters. Another explanation offered for this finding is that in the past the U.S. has supplied heavy concessional imports in these same areas, resulting in the establishment of marketing channels. Overall, results indicate that U.S. export demand is responsive to price and foreign exchange rate changes. The authors point out that though these relationships exist, lowering the price of U.S. wheat may not be very effective in increasing export quantities because the other major exporters tend to follow the U.S. price changes.

Chapter Summary

Previous studies have emphasized various aspects of modelling import demand. Some explore the appropriateness of certain model forms given the implicit assumptions within the functional form while others place more emphasis on the specific variables included in the model.

In general, multiple commodity import demand models have focused on the general form of the model and on the correctness of certain implied assumptions within the model. Some issues addressed by these models include deciding the correct functional form, measuring cyclical versus secular variations, and using real versus nominal variables.

In contrast, the single commodity import demand models have emphasized the inclusion and significance of specific variables within the model. These models stress the measurement of imports along with determining various elasticities of import demand. Price, income, and market share elasticities, along with foreign reserves are some of the specific variables tested in these models.

The export demand models are similar to the single commodity import demand models in that they also tend to emphasize the inclusion and significance of specific variables in the model. Variables studied in the existing export demand literature include foreign exchange rates, price transmission elasticity, price elasticity, and income elasticity.

CHAPTER III

THEORY CHAPTER

Chapter III is a review of the economic theory underlying import demand models. The role of trade in the world economy will be discussed first, then the components of import demand are introduced. Then the determinants of those components, domestic demand and domestic supply, are reviewed in order to point out the factors that impact the import demand function. The last section of Chapter III discusses the derivation of elasticities from the import demand function.

The Role of Trade

Trade is a necessary part of the world economy. It occurs because some countries have an advantage over others in producing certain goods, while other goods can only be produced in certain countries. Resources are better allocated when countries specialize in producing those goods in which they have relatively lower pre-trade marginal production costs than other countries and exchange surplus production for the goods which they do not or cannot produce domestically. This theory of comparative advantage is the basis for specialization in production which "implies trade and cannot occur without it" (Chacholiades, p. 6). Specialization creates trade and potentially increases total world output.

Comparative Advantage

The theory of comparative advantage may be explained using the concept of opportunity costs in a two-country two-commodity example (Table IV). If resources are defined as all inputs, including labor, required in production, then Country A holds an absolute advantage in both products in terms of resource efficiency; however, Country A can still gain from specialization and trade because of the opportunity costs involved in using resources for the production of product Y versus product X. Chacholiades (1978) defines the opportunity cost of Y in terms of X for country A as the "minimum amount of X which A has to give up in order to produce an additional unit of Y" (Chacholiades, p. 22). Country A must give up one half unit of product X in order to produce one additional unit of product Y; in contrast, Country B must give up two units of product X to produce an additional unit of product Y. Therefore, Country A holds the comparative advantage over Country B in production of product Y in terms of opportunity costs. For product X, Country B must forego one half unit of Y to produce an additional unit of X as compared to Country A which must give up 2 units of Y to produce an additional unit of X. In the production of X, Country B holds the comparative advantage over Country A.

If each country specializes in the production of the product in which they have a lower opportunity cost than the other country, given immobile resources, Country A will produce product Y and Country B will produce product X. If resources were mobile, resources would move to Country A which holds an absolute advantage in both products. However, with specialization of production, trade will occur and a greater amount of each product will be available than was produced before trade.

TABLE IV

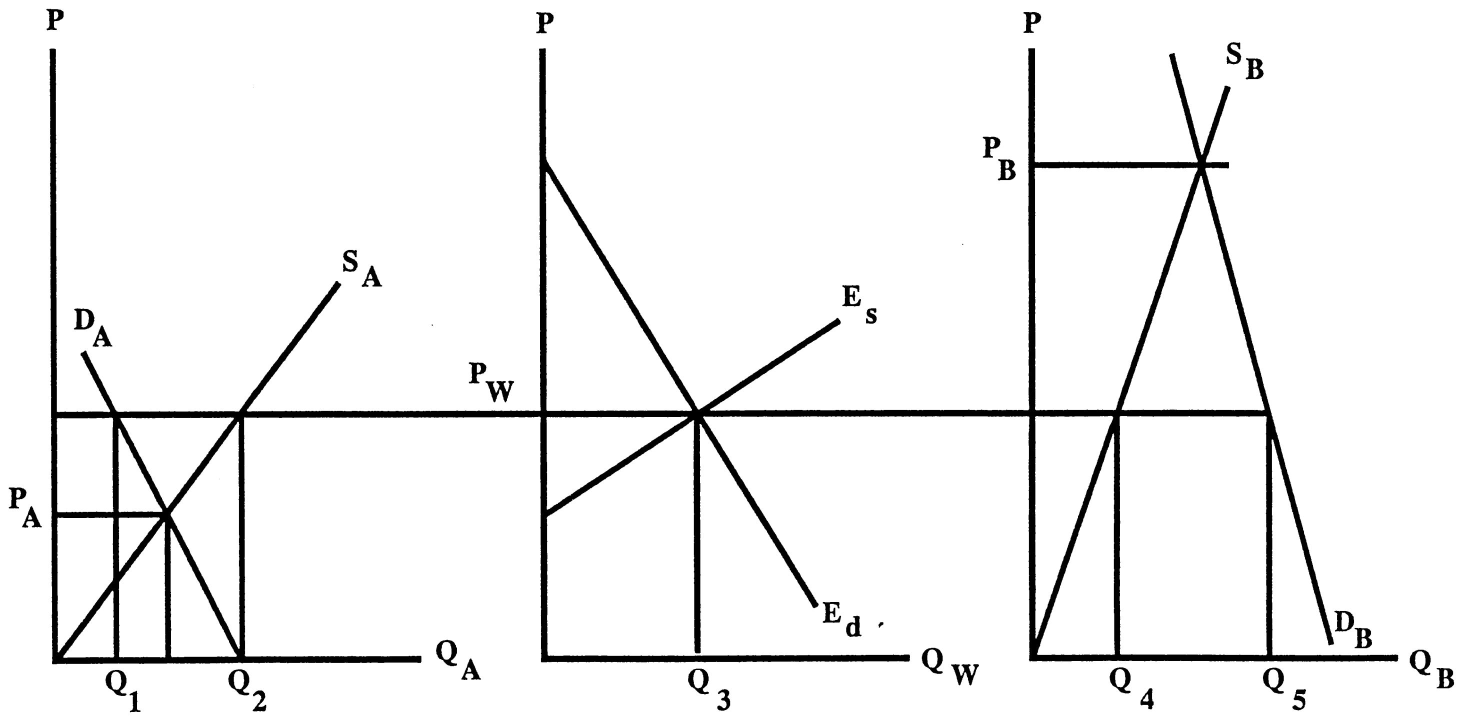
TWO-COUNTRY COMPARATIVE ADVANTAGE EXAMPLE

Product	Resource Requirements per Unit of Output Country A	Country B
Product X	2	3
Product Y	1	6

According to the theory of comparative advantage, a country will export the product in which it holds a comparative advantage and will import products in which it has a comparative disadvantage. This study focuses on growth in import markets so the following discussion is centered on determining import volume rather than export volume.

Theory of Import Demand

Import demand may be defined as the difference between domestic demand and domestic supply when domestic and imported goods are considered to be perfect substitutes and is graphically illustrated in Figure 1. At Country B's domestic price of P_B, domestic demand (D_B) equals domestic supply (S_B). However, at any price below P_B, Country B's domestic demand exceeds domestic supply thus creating an excess or import demand (E_d) function for Country B. The increase in demand is satisfied by the excess or export (E_s) supply of Country A at prices above P_A. The equilibrium for the



Country A **World Market** **Country B**

Figure 1. Two-Country, One-Commodity Model of International Trade Assuming Perfect Substitution

world market is reached at the world price of P_W where excess supply equals excess demand. At P_W, Country B will import the quantity (Q_5-Q_4) and Country A will export the quantity (Q_2-Q_1). Both (Q_5-Q_4) and (Q_2-Q_1) are equal to Q_3, the quantity traded on the world market.

Complementary and Substitutable Imports

Imports can be separated into two categories with respect to domestic production. Complementary imports are those goods which are not produced domestically and are considered to have no domestic substitute. Substitutable imports are products equal to or very similar to goods produced domestically and have domestic substitutes. A country's total imports will typically include both complementary and substitutable products.

Import Demand Variables

Because import demand is a function of domestic demand, shifts in the domestic demand function will cause a shift in import demand. It follows that the explanatory variables of import demand are based on consumer theory which emphasizes utility maximization. This suggests that the consumer's income, the price of imports, and the price of other consumable commodities will determine the quantity of imports purchased by the individual consumer. The function can be written as

$$M = \frac{V_M}{p_M} = f(p_m, p_y, Y) \tag{3.1}$$

where M is the quantity of imports, V_M is the value of imports, Y is domestic income, p_M is the price level of imports, and p_Y is the price level of domestic goods (Leamer and Stern, 1970). Individual consumers' import demand curves are then aggregated to determine the market's import demand curve.

Perfect Substitutes Models

If imports are imperfect substitutes for domestic goods, the discussion could end here. However, if imports are perfect substitutes for domestic goods, then domestic supply must be considered in determining import demand. The import demand function would then appear as

$$M=f(S,Y,p,p_A) \tag{3.2}$$

where M is total imports of the good, S is the domestic supply shifter, Y is domestic income, p is the world price of the good, and p_A is the price of an alternative (but imperfect) substitute for the good. Here the capacity of import-competing industries is included to aid in explaining variations in import demand (Leamer and Stern, 1970). The factors that determine domestic demand and domestic supply will be discussed more specifically in later sections.

The import demand function is generally used to explain purchases of imports by a country as a whole. Macroeconomic factors may have a significant impact on the quantity imported by a country. Such factors include dummy variables for seasonal variation, lagged variables, foreign exchange reserves, real GNP, available credit, relative price of imports, dummy variables for unusual periods, and the degree of capacity utilization (Leamer and Stern, 1970). The foundation of a direct demand estimation is, however, consumer behavior. The following discussion focuses on the factors that affect the individual consumer's purchasing behavior.

Consumer Behavior Theory

Individual consumers "choose among the available alternatives in such a manner that the satisfaction derived from consuming commodities (in the broadest sense) is as large as possible" (Henderson and Quandt, 1980). This is the assumption of utility maximization and is the basis for consumer behavior theory.[1] The consumer seeks to maximize his satisfaction or utility subject to a budget constraint.

Individual Demand Functions

Assume that the consumer has a budget of Y^o and a choice of two commodities, q_1 and q_2. Mathematically, utility is maximized by using the Lagrangian function

$$£=f(q_1,q_2)+\lambda(y^o-p_1q_1-p_2q_2) \tag{3.3}$$

where £ is the Lagrangian function, λ is the Lagrangian multiplier, Y is income, and p is price.

First order partial derivatives are taken from Equation 3.3 and set equal to zero in order to satisfy the first order conditions for maximization as in

$$\frac{\partial £}{\partial q_1} = f_1-p_1\lambda=0 \tag{3.4a}$$

$$\frac{\partial £}{\partial q_2} = f_2-p_2\lambda=0 \tag{3.4b}$$

$$\frac{\partial £}{\partial \lambda} = y^o-p_1q_1-p_2q_2=0 \tag{3.4c}$$

The ordinary demand functions for q_1 and q_2 as a function of p_1, p_2, and y^o can be obtained by solving equations 3.4a through 3.4c simultaneously for q_1 and q_2.

The first order partial derivatives of equation 3.3 with respect to P_1, P_2, and Y_o, determine the impact that each variable has on demand for the commodity.

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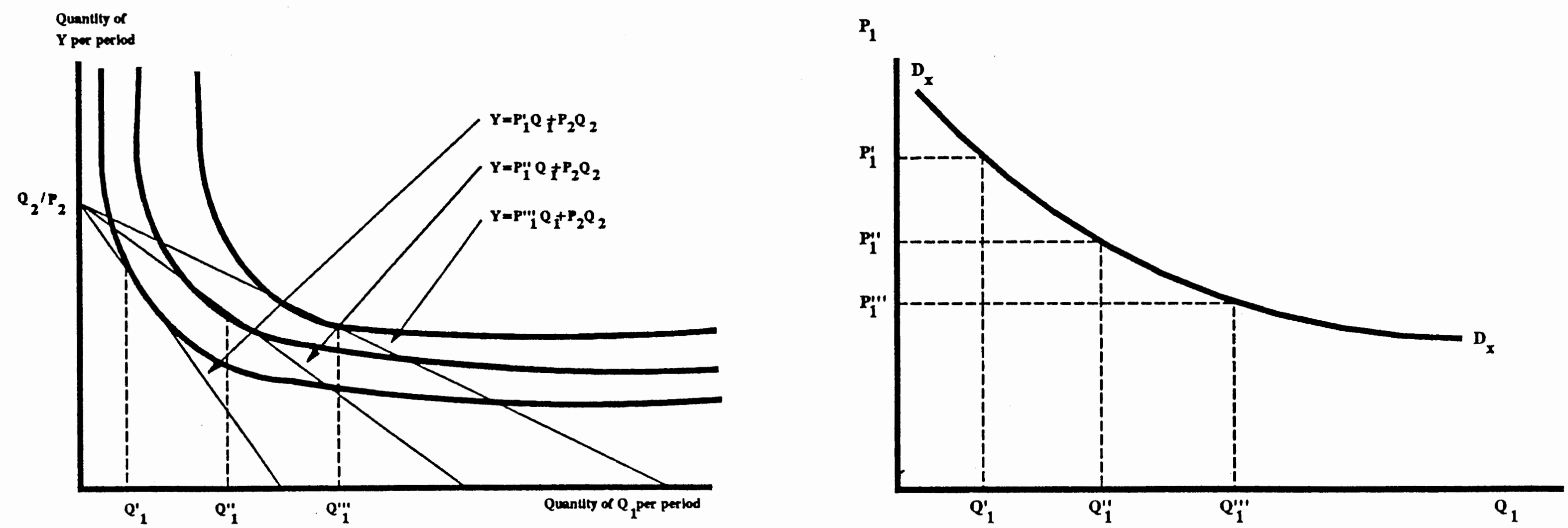
[1]The formulas in this section are from Henderson and Quandt, pp. 13-15, 1980.

$\frac{\partial q_i}{\partial p_i}$ represents the own price effect of ordinary demand. The expected sign of the own price effect is negative, as indicated by the law of demand. Thus, if the price of a commodity increases, consumers will purchase less of that commodity. The expected sign of the cross price effects will depend upon the relationship of the commodities involved. If $\frac{\partial q_i}{\partial p_j}<0$, then q_1 and q_2 are gross complements, while $\frac{\partial q_i}{\partial p_j}>0$ indicates that q_1 and q_2 are gross substitutes. If they are gross complements, an increase in the price of q_2 will imply a decrease in the demand for both commodities. If they are gross substitutes, an increase in the price of q_2 implies an increase in the demand for q_1. Assuming that q_1 is a normal good, $\frac{\partial q_1}{\partial y_o}>0$, so that an increase in income also increases the demand for q_1.

Graphically, the ordinary demand function can be derived from the same two-commodity example used for the mathematical derivations. With the assumptions that (1) the consumer has a fixed income to allocate between purchases of q_1 and q_2, (2) P_2 does not change, and (3) tastes and preferences are constant, an indifference (utility) curve map and the consumer's ordinary demand curve can be illustrated as in Figure 2. The indifference curves show "those combinations of goods that provide the same level of utility to an individual" (Nicholson, p. 57, 1983). The demand curve for q_1 can be constructed by allowing P_1 to change, effectively changing the consumer's budget constraint, thus placing the consumer on a new indifference curve and affecting the quantity of q_1 demanded. Any changes in Y^o, P_2, or tastes and preferences will shift the demand curve to the left or right rather than move the consumer along the curve.



(a) Individual's indifference curve map **(b) Demand Curve**

Figure 2. Construction of an Individual's Demand Curve

Market Demand Functions

The market demand function for a commodity is obtained by horizontally aggregating individual demand functions for the commodity as in Figure 3. Market demand for a good is defined by Nicholson as the "total quantity demanded by all potential buyers of that good" (p. 168). At each price in the market, the market demand function represents the sum of all individual quantities demanded for that good. Any shift in an individual's demand curve will thus cause the market demand to shift. Therefore, own price, the price of other goods, and income will affect the market demand for a commodity.

Theory of the Firm

Neoclassical economic theory draws on the assumption that the individual producer's goal is to maximize profit. In perfect competition, the producer will make decisions regarding the quantity of output to be produced based on the price per unit of output and the costs of those inputs required for production. The difference between revenue from outputs and the costs of inputs is the producer's profit (or loss, if negative).

Individual Production Function

A production function "shows the maximum amount of output attainable from a particular set of inputs" (Nicholson, p. 190). In a production process with two variable inputs, the production function can be written as

$$q=f(x_1,x_2) \tag{3.5}$$

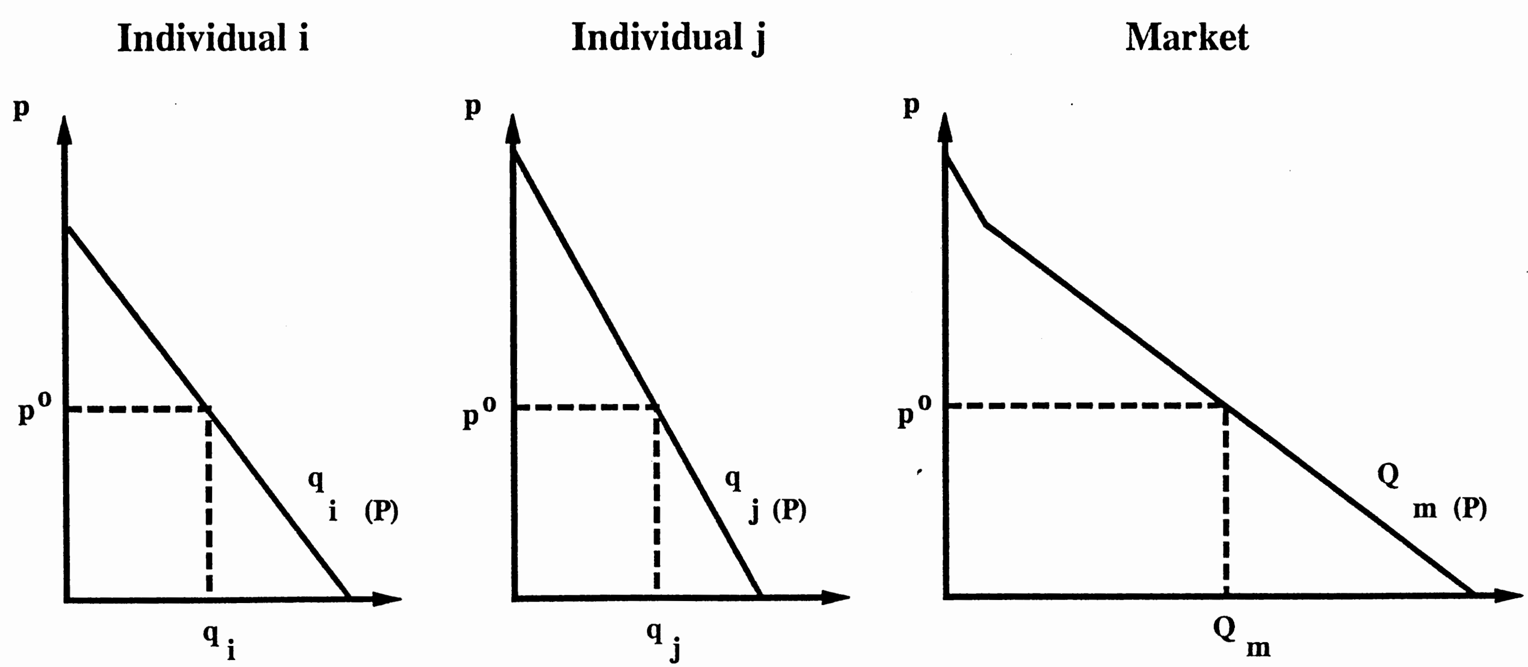


Figure 3. Market Demand Function

where q is the output and x_1 and x_2 are variable inputs.[2] The function is defined only for positive values of q, x_1, and x_2.

Profit is maximized with respect to the variable inputs by the function

$$\pi=pf(x_1,x_2)-r_1x_1-r_2x_2-b \tag{3.6}$$

where π is profit, p is the market price of output, x_1 and x_2 are variable inputs, r_1 and r_2 are the respective input prices, and b is fixed producer costs. The first order partial derivatives of the function with respect to x_1 and x_2 are set equal to zero:

$$\frac{\partial\pi}{\partial x_1}=pf_1-r_1=0 \qquad \frac{\partial\pi}{\partial x_2}=pf_2-r_2=0 \tag{3.7}$$

By moving the input prices to the righthand side of the equation as in

$$pf_1=r_1 \quad \text{and} \quad pf_2=r_2 \tag{3.8}$$

the value of the marginal product of the input is set equal to the factor cost. Therefore, the producer can increase his profit as long as the use of an additional unit of an input generates more revenue than the cost of the additional unit.

Individual Producer Supply Functions

In a perfectly competitive product market, the supply function of a producer "gives the quantity that he will produce as a function of product price" (Beattie and Taylor, p. 164). The producer's profit is maximized in equation 3.6 by choosing the optimum input levels. Assuming perfect competition in both the factor and product markets, the producer's supply curve can be obtained by considering the same profit maximization problem from the output side (Beattie and Taylor) as in

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[2]The equations for profit maximization rely heavily on information found in Henderson and Quandt.

$$\pi = pQ\text{-}c\ (r_1,r_2,y) - b \tag{3.9}$$

where Q represents output, c is total variable cost as a function of input prices and output, and b represents fixed costs associated with production.[3] Input prices are exogenous. The first order conditions for profit maximization yield

$$\frac{d\pi}{dQ} = p - \frac{\partial c(r_1,r_2,Q)}{\partial Q} = 0 \tag{3.10}$$

which states that for profit maximization, marginal revenue must be equal to marginal cost. The producer's supply function is derived by solving the marginal cost function (first order conditions) for the inverse function

$$Q^* = Q^*(p,r_1,r_2) \tag{3.11}$$

The supply function is disjointed because at points below the minimum of the average variable cost function, the producer will not produce.

As defined by Nicholson, the "short-run supply curve for a perfectly competitive firm will be the positively sloped section of its short-run marginal cost curve above the point of minimum average variable cost" (p. 319). This is illustrated in Figure 4 where at points equal to or above p_o, the producer will produce Q until marginal cost equals marginal revenue. At points below p_o, the producer will minimize losses with no production. Changes in factor prices will shift the producer's supply function.

Market Supply Functions

The market supply function for a commodity can be derived by horizontally aggregating individual producer's supply curves. The market supply curve shows the quantity supplied to the market by individual producers at each possible market price (Nicholson, 1983). Figure 5 illustrates the horizontal

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[3]The equations for the derivation of individual supply function are from Beattie and Taylor.

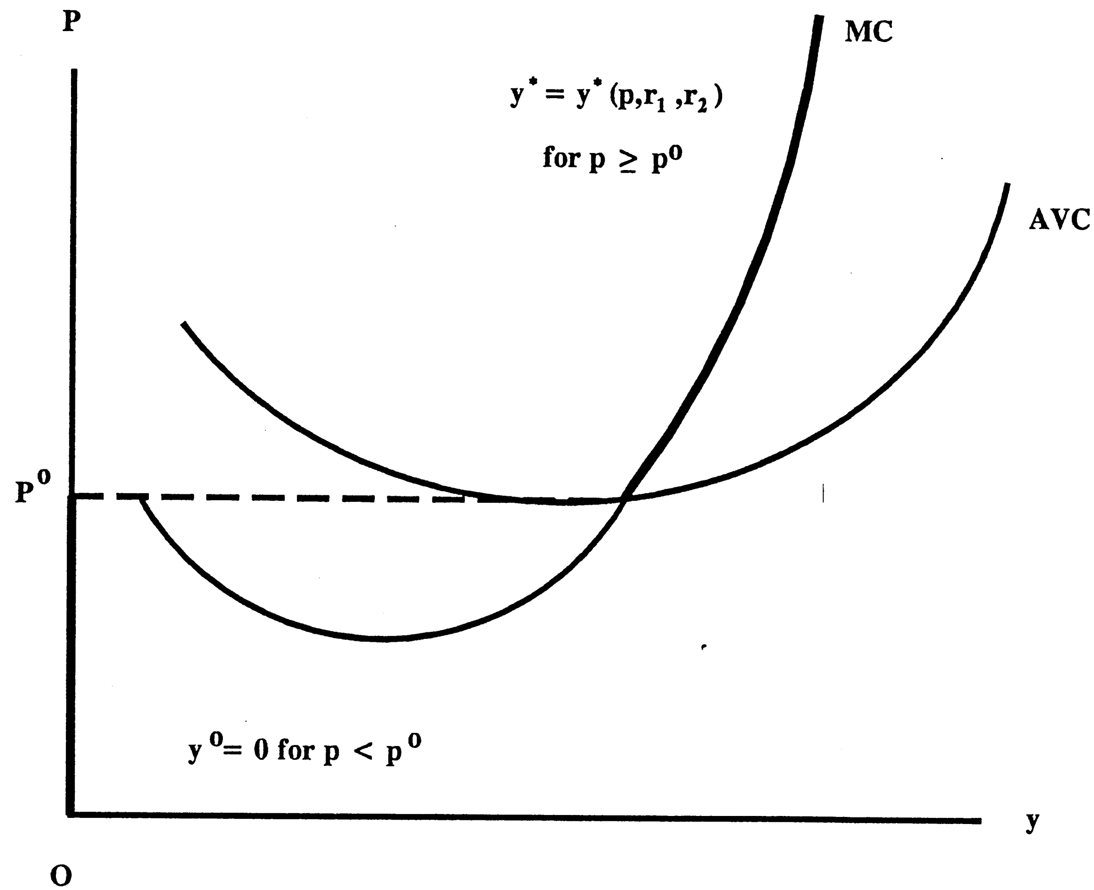

Figure 4. Producer Supply Function

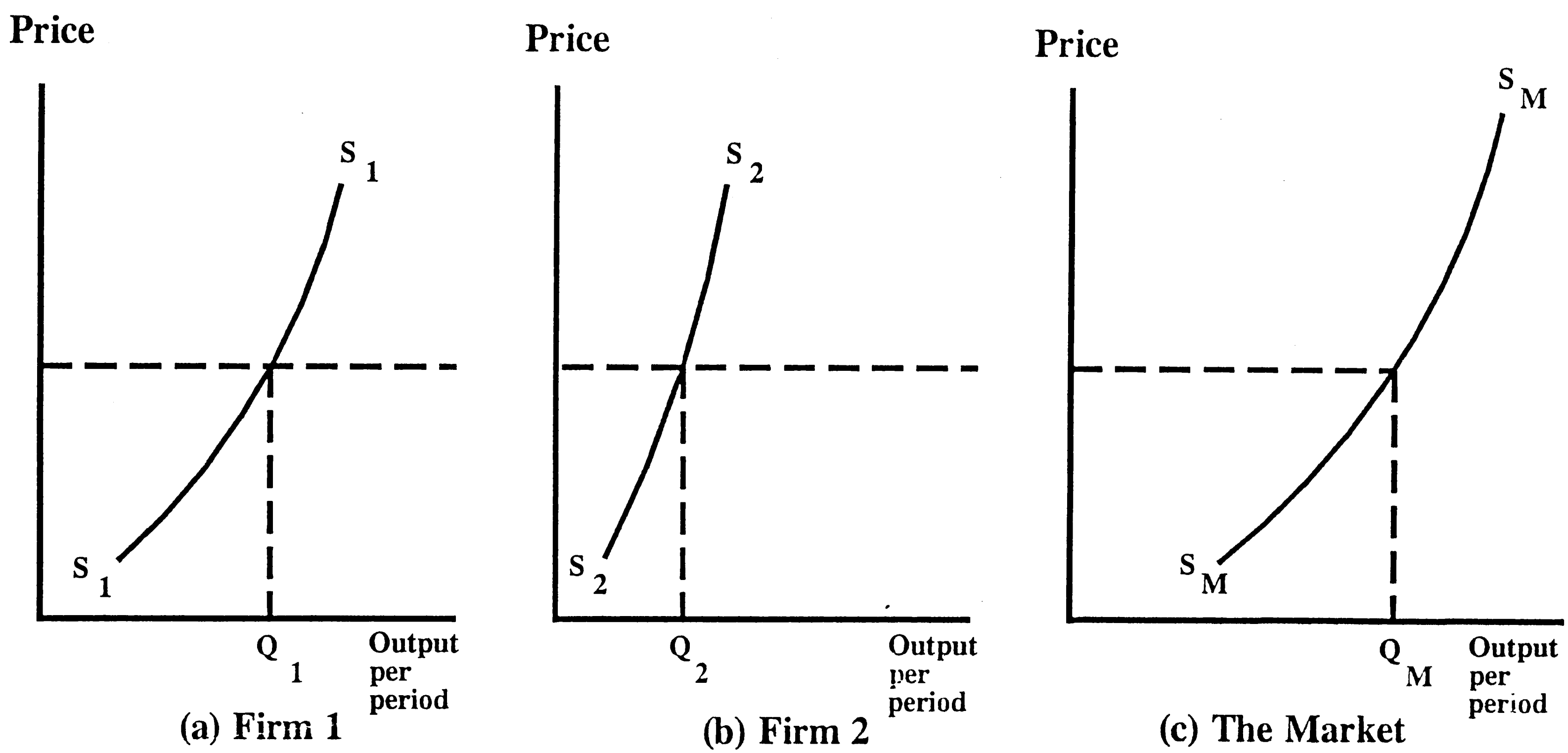

Figure 5. Short-Run Market Supply Curve

aggregation of individual supply curves to form the market supply curve. If Producer A supplies quantity Q_1 and Producer B supplies quantity Q_2 for a given time period, the supply available on the market for the period will be $(Q_1 + Q_2)$ which is equal to Q_m. Any shift in an individual producer's curve will also shift the market supply curve. Logically, the same factors that affect the individual producer will affect the market supply curve. Those factors include input costs and output price.

Elasticity of Import Demand

The theory of demand necessitates that changes in the values of consumption variables will change the quantity demanded of the good in question. The magnitude of these changes can be measured using elasticities that measure percentage changes in quantity demanded relative to a 1 percent change in the consumption variable. Elasticities are determined by (1) the slope of the demand curve and (2) the position of the point at which elasticity is evaluated. The import demand function is the difference between the domestic demand function and domestic supply function below the autarky (self-sufficiency) price. It follows then that the slope, and thus partially the elasticity, of the import demand function is dependent upon the slopes of the domestic demand and supply functions (McCalla, 1985). Commonly derived elasticities with respect to demand are own-price, cross-price, and income elasticities.[4]

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[4]The following calculations of these elasticities are adapted from Henderson and Quandt, 1980.

Own-Price Elasticity

The own-price elasticity of demand for a good measures the magnitude of the effect that a change in the price of the good has on the quantity of the good demanded. Mathematically, it is written as

$$\varepsilon_o = \frac{\partial(\ln q_1)}{\partial(\ln p_1)} = \frac{p_1}{q_1}\frac{\partial q_1}{\partial p_1} \tag{3.12}$$

where ε_o is the own price elasticity of demand. The expected sign of the own-price elasticity for a normal good with a downward sloping demand curve is negative. A high elasticity value (less than -1) indicates a luxury good, while goods with low elasticity values (greater than -1) are considered necessities.

Cross-Price Elasticity

The cross-price elasticity of demand for a good measures the proportional change in the quantity demanded of a good resulting from a proportional change in the price of another good. It can be shown as

$$\varepsilon_c = \frac{\partial(\ln q_1)}{\partial(\ln p_2)} = \frac{p_2}{q_1}\frac{\partial q_1}{\partial p_2} \tag{3.13}$$

where ε_c represents the cross-price elasticity of demand. The cross-price elasticity for a good may be either positive or negative, depending upon the relationship between the goods compared. For a complementary good, the cross-price elasticity is expected to be negative, while the cross-price elasticity for a substitute good is expected to be positive.

Income Elasticity

The income elasticity of demand for a good measures "the proportionate change in the purchase of a commodity relative to the proportionate change in income with prices constant" (Henderson and Quandt, 1980, p. 22). Mathematically, it is

$$\eta = \frac{\partial(\ln q_1)}{\partial(\ln y)} = \frac{y}{q_1}\frac{\partial f(p_1,p_2,y)}{\partial y} \tag{3.14}$$

where η is the income elasticity of demand. The income elasticity for a good can take any sign, but is assumed to be positive for a normal good.

Elastic and Inelastic Demand Curves

For a linear demand curve, elasticity values will vary along the curve. At the point where the elasticity of demand is equal to one, the curve is said to be unit elastic. In the elastic portion of the curve, price decreases will result in increases in total revenue. Price decreases in the inelastic portion of the curve will result in decreases in total revenue. The elasticity of a linear demand curve is different at each point on the curve.

When a demand curve is assumed to be logarithmically linear, the elasticities are constant for each point on the curve (Nicholson, 1983). For a log-linear demand curve

$$\ln Q = a+b\ln P \tag{3.15}$$

and b is the price elasticity of demand.

Import Demand Elasticities

Kreinin (1975) states that "the elasticity of import demand for a given product is positively (and uniquely) related to the domestic demand and supply elasticities, negatively related to the share of imports in domestic consumption and production" (p. 428). As stated earlier in the chapter, the slope of the import demand function is dependent on the slopes of the domestic demand and domestic supply functions. More elastic domestic demand and domestic supply functions will result in an import demand function with a higher elasticity than an import demand function derived from less elastic domestic functions. As the market share of imports increases for a given product, the import demand function will become less elastic. Demand for the good will move toward the less elastic portion of the domestic demand curve, thus toward the less elastic portion of the import (excess) demand curve.

The import demand elasticity with respect to price can then be derived using domestic supply and demand, as in

$$\eta_m = \frac{-P}{Q_m}\frac{\Delta Q_m}{\Delta P} = \frac{-P}{Q_m}\frac{\Delta(Q_d - Q_s)}{\Delta P} = \frac{-P}{Q_m}\frac{\Delta Q_d}{\Delta P} + \frac{P}{Q_m}\frac{\Delta Q_s}{\Delta P} \qquad (3.16)$$

where Q_m is the volume of imports, Q_d is domestic quantity demanded, Q_s is domestic quantity supplied, and n_m is import demand elasticity.[5] The first term can be multiplied by $\frac{Q_d}{Q_d}$ and the second by $\frac{Q_s}{Q_s}$ to obtain

$$\eta_m = \frac{Q_d}{Q_m}\varepsilon_d + \frac{Q_s}{Q_m}\varepsilon_s \qquad (3.17)$$

where ε_d is the domestic demand elasticity with respect to price and ε_s is the domestic supply elasticity with respect to price.

The previous discussion of import demand elasticities ignores the effect of trade barriers on elasticity values. Trade barriers are generally implemented "as a mechanism for giving an increased share of the market to domestic producers" (McCalla, p. 33). Trade barriers which tend to decrease the market share of imports for a given product will move import demand along the function toward the inelastic portion of the import demand curve.

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[5]The equation for the elasticity of import demand is modified from Kreinin, 1975.

Summary

The economic theory underlying import demand models encompasses several topics. The theory of comparative advantage explains why nations trade with each other and specialize in the production of certain goods. When trade occurs, the import demand for products which are considered perfect substitutes for domestic products is determined by the domestic demand and the domestic supply functions. Because both demand and supply influence import demand, consumption and production variables will have an effect on the import demand function. The consumption variables included in a particular import demand equation will depend on whether or not the separability of utility functions is assumed.

Elasticities for import demand may be measured using the same concepts as elasticities for domestic demand. Own-price elasticity, cross-price elasticity, and income elasticity are commonly derived import demand elasticities.

CHAPTER IV

DATA AND METHODOLOGY

The models and data employed in the empirical estimations are discussed in Chapter IV. First, the data used in the analysis is defined. Next, the theoretical econometric model used for the empirical analysis, which is specifically designed for pooled cross-sectional and time-series data, is introduced. The country selection and categorization process is specified and the behavioral models for agricultural import demand are presented. Finally, statistical tests used to determine differences between categories are reviewed.

Data and Sources

The following is a description of the data used in the study. In this study, aggregated agricultural imports are assumed to be perfect substitutes for domestic agricultural products. Agricultural import demand then becomes a function of price, income, population, and domestic supply. Factors such as trade barriers and other policy variables are excluded from the model because (1) policy variables are not consistent across the study group and (2) the addition of unique variables for each country would change the comparability of other variables across countries or between subgroups. Data sources varied in the base year used to calculate indices; therefore, each index was transformed using 1974 as the base year to ease interpretation of results. The descriptions contain information about the method each source used in calculating the original index. Using index numbers to measure changes in each independent variable results in uniform units (percent) across variables.

IMPORT represents the FAO volume index for total agricultural imports. It measures import volume of all agricultural products, including both food and non-food components.[6] The index is calculated using the price-weighted sum of quantities imported with 1979-1981 as the base time period. It can be written as

$$\frac{\Sigma p_o q_n}{\Sigma p_o q_o} \tag{4.1}$$

where o refers to the base period and n refers to the current period. The summation sign indicates the summation of all commodities included in the index. The FAO index of import volume was not available for China. A reasonable estimate of the import volume index was obtained by multiplying the FAO import unit value index by the FAO import value index and dividing by 100.

UVAL represents an import unit value index calculated using the World Bank Consumer Price Index (CPI) for the United States and the FAO unit value index which measures changes in the 1979-1981 quantity-weighted unit values in U.S. dollars of aggregated agricultural imports. The U.S. CPI is used to convert the FAO index from nominal figures to real figures. The U.S. CPI is used rather the individual country's CPI because (1) FAO data is in U.S.

[6]It should be noted that some countries included in the study report imports on the basis of general trade which includes all imports regardless of destination, while others report imports on the basis of special trade which includes only those products intended for domestic consumption or use. Those countries reporting on the basis of general trade are Canada, China, Hong Kong, United States, United Kingdom and Japan. Those countries reporting on the basis of special trade are Belgium-Luxembourg, Egypt, France, Federal Republic of Germany, Italy, Republic of Korea, Netherlands and Spain.

dollars, (2) the U.S. dollar is commonly used by other countries as an international trade currency (Madura, p. 23), and (3) it is assumed that the import price is assessed at the border before domestic inflation affects the price of goods. The final result is shown by

$$\frac{\frac{\Sigma p_n q_o}{\Sigma p_o q_o} * CPI}{100} \tag{4.2}$$

where $\frac{\Sigma p_n q_o}{\Sigma p_o q_o}$ is the FAO import unit value as o refers to the base period and n refers to the current period. Again, the summation sign indicates the summation of all commodities included in the index.

GDP is an index of real Gross Domestic Product calculated using values given in the World Bank World Tables. The World Bank values are measured in the country's local currency in constant prices using 1987 as a base period. The index was calculated as

$$\frac{GDP_n}{GPD_o} * 100 \tag{4.3}$$

where o refers to the 1987 base value and n refers to the current year's real value as reported by the World Bank.[7]

POP represents an index of population calculated using the FAO rural and urban population figures. Rural and Urban populations were summed to obtain total population. 1974 was used as a base period to create the index. The index was calculated as

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[7]GDP figures for 1990 were not available for any of the countries included in the study; also, 1989 figures were not available for the Federal Republic of Germany. Estimated GDP figures were calculated using each country's average annual rate of growth in GDP from 1986 to 1989 with the exception of the Federal Republic of Germany for which the average annual rate of growth in GDP from 1986 to 1988 was used.

$$\frac{POP_n}{POP_o}*100 \tag{4.4}$$

where n refers to the current period and o refers to the base period.

PROD is the FAO index for total agricultural production within a country. Production is reported on a calendar year basis with crops being reported in the year during which the bulk of harvest takes place. It includes only disposable production, thus excluding feed and seed use. The index uses 1979-1981 as a base time period.

The FAO Trade Yearbook provided data for the import volume index (IMPORT) and import unit value index (UVAL). The domestic production index (PROD), along with information used to calculate the population index (POP), was taken from the FAO Production Yearbook. The World Bank World Tables provided Gross Domestic Product figures and the Consumer Price Index for the United States.

Pooled Cross-Sectional and Time Series Estimation Model

An analysis of import demand in several countries as a group over time introduces the pooling of cross-sectional and time-series data. A typical problem in cross-sectional data is non-constant variances in the error term, while with time-series data the errors may be correlated over time. Pooling the data creates the possibility of both problems occurring simultaneously (Dielman, 1989). Kmenta (1985) presents a method which deals with both problems concurrently and is the model used for empirical analysis in this particular study. This cross-sectionally heteroskedastic and timewise autoregressive model assumes

(1) heteroskedasticity, as in $E(\varepsilon_{it}^2) = \sigma_i^2$ (4.5a)

(2) cross-sectional independence, as in $E(\varepsilon_{it}\varepsilon_{jt}) = 0 \quad (i \neq j)$ (4.5b)

and

(3) autoregression, as in $\varepsilon_{it} = \rho_i \varepsilon_{i,t-1} + U_{it}$ (4.5c)

where $u \sim N(0,\sigma_{ui}^2)$, $\varepsilon_{i1} \sim N(0, \frac{\sigma_{ui}^2}{1-\rho_i^2}$ and $E(\varepsilon_{i,t-1}, u_{jt}) = 0$ for all i, j.

If heteroskedasticity or autoregression is present in the data set, the variables are transformed to remove the effects. If neither is present, the coefficients are equivalent to those estimated using Ordinary Least Squares.

The correlation coefficient ρ, which measures the correlation of error terms through time, is allowed to vary between cross-sectional units. This implies that the error terms for one cross-sectional unit across time are correlated in that

$$E(\varepsilon_{it}\varepsilon_{is}) = \rho^{t-s}\sigma_i^2 \quad (t \geq s), \tag{4.6}$$

and that the error terms between cross-sectional units across time are not correlated as in

$$E(\varepsilon_{it}\varepsilon_{js}) = 0 \quad (i \neq j). \tag{4.7}$$

The first step in the model applies ordinary least squares (OLS) to the data. The regression coefficient results from this regression are used to calculate regression residuals, e_{it} , and estimate ρ_i by

$$\hat{\rho}_i = \frac{\Sigma e_{it} e_{i,t-1}}{\sqrt{\Sigma e_{it}^2}\sqrt{\Sigma e_{i,t-1}^2}} \quad (t=2,3,\ldots,T). \tag{4.8}$$

This method confines the estimator of ρ_i to the interval from -1 to +1 for any sample size (Kmenta).

The $\hat{\rho}_i$'s are then used to transform the observations to be nonautoregressive. This is done by applying

$$Y^*_{it} = \sqrt{1-\hat{\rho}_1^2}\,Y_{it} \quad t=1, \tag{4.9}$$

$$Y^*_{it} = Y_{it}-\hat{\rho}_i Y_{i,t-1} \quad t=2,3,\ldots,T,$$

to the dependent variable observations, and

$$X^*_{it,k} = \sqrt{1-\hat{\rho}_1^2}\,X_{it,k} \quad t=1 \tag{4.10}$$

$$X^*_{it,k} = X_{it,k} - \hat{\rho}_i X_{i,t-1,k} \quad t=2,3,\ldots,T,$$

$k = 1, 2, \ldots, K$, and $i = 1, 2, \ldots, N$ to the independent variable observations where T represents the number of time periods observed, N represents the number of cross-sectional units and K represents the number of explanatory variables to obtain

$$Y^*_{it} = \beta_1 X^*_{it,1} + \beta_2 X^*_{it,2} + \ldots + \beta_k X^*_{it,k} + u^*_{it}. \tag{4.11}$$

Ordinary Least Squares is applied to the transformed observations in order to obtain a consistent estimate of σ^2_{ui}, which is s^2_{ui}, the variance of u_{it}.

The variables are then further transformed to remove heteroskedasticity. This is done by dividing each transformed observation by s_{ui} as in

$$Y^{**}_{it} = \frac{Y^*_{it}}{s_{ui}}, \tag{4.12a}$$

$$X^{**}_{it,k} = \frac{X^*_{it,k}}{s_{ui}} \quad (k=1,2,\ldots,K), \tag{4.12b}$$

$$u_{it}^{**} = \frac{u_{it}^{*}}{s_{ui}} \tag{4.12c}$$

where t = 1, 2, . . . , T, and i = 1, 2, . . . , N to obtain

$$Y_{it}^{**} = \beta_1 X_{it,1}^{**} + \beta_2 X_{it,2}^{**} + \ldots + \beta_K X_{it,k}^{**} + u_{it}^{**} . \tag{4.13}$$

The final estimates of the regression coefficients are then obtained by applying OLS to the final transformation of variables. The resulting disturbance term u_{it}^{**} is asymptotically nonautoregressive and homoskedastic.

Selection of Countries

Countries were selected for the empirical analysis based on market size for agricultural imports in 1989. The original intent of the study was to analyze the 15 largest agricultural import markets; however, political changes and data problems reduced the actual study size to 12 countries. The USSR was excluded because of the uncertainty recent political changes have brought for the newly independent Soviet countries. Spain and Korea were excluded from the study due to the unavailability of an accurate measurement of agricultural import volume.

The selected countries were further categorized into high growth, medium growth, and low growth groups as determined by average annual growth rates of agricultural imports from 1985 to 1989. Countries were ranked in descending order by growth rate. The low growth group was categorized as any country whose growth rate was below one-half of the range of growth rates within the group added to the lowest growth rate in the study group. Ten percent of the highest growth rate in the study group was then added to the highest rate in the low group. Countries with growth rates below this calculated rate, but above the low group ceiling, were included in the middle growth group. The remaining countries were included in the high growth group. China, Hong Kong, Italy, Japan, and France comprise the high growth group; the Netherlands and the German Federal Republic make up the middle growth group; and Belgium-Luxembourg, the United Kingdom, Egypt, Canada, and the United States are in the low growth group.

Import Demand Model

As discussed in Chapter III, import demand is a function of both domestic demand and domestic supply when imports are considered as perfect substitutes for domestic goods. It is assumed in this study that, in aggregate, agricultural imports are perfect substitutes for domestic agricultural products though total agricultural imports for a particular country may contain both perfect and imperfect substitutes. Therefore, import demand is a function of its own price, prices of domestic goods, income, population, and domestic supply.

Aggregated Import Demand Model

Kmenta's cross-sectionally heteroskedastic and timewise autoregressive method was used to estimate the following model representing total agricultural import demand for twelve countries using time-series data from 1974 through 1990.

$$IMPORT_t = \beta_0 + \beta_1 UVAL_t + \beta_2 GDP_t + \beta_3 POP_t + \beta_4 PROD_t + u_t \qquad (4.14)$$

where

IMPORT = agricultural import volume index,

UVAL = agricultural import unit value index,

GDP = gross domestic product index,

POP = population index,

PROD = domestic agricultural production index,

u = random disturbance, and

t = year.

A volume index for net agricultural imports was not available and the aggregation of products made it impossible to obtain the necessary information to calculate an accurate measure of the volume of net imports. Therefore, the FAO index for gross agricultural import volume was used as a proxy for net agricultural imports and the assumption is made that a one percent change from the base in gross imports would approximate a one percent change from the base in net imports. Domestic supply is a function of many factors such as land availability, input prices, and output prices. It is difficult to obtain consistent measurements of these factors across countries; thus, domestic agricultural production was used as a proxy for the factors which affect domestic supply.

Import Demand Model for Growth Groups

The model in Equation 4.14 assumes that the parameters for each variable are identical across groups. However, it is possible that the parameters are distinctly different for each growth group. A modified version of the basic model was used to estimate separate coefficients for each growth group. The modified model is

$$IMPORT_t = \beta_0 + \beta_{0H}HDUM + \beta_{0L}LDUM + \beta_1 UVAL_t + \beta_{1H}HUVAL_t + \beta_{1L}LUVAL_t + \beta_2 GDP_t + \beta_{2H}HGDP + \beta_{2L}LGDP_t + \beta_3 POP_t + \beta_{3H}HPOP_t + \beta_{3L}MPOP_t + \beta_4 PROD_t + \beta_{4H}HPROD_t + \beta_{4L}LPRODt \quad (4.15)$$

where dummy variables and dummy interaction variables are used to capture differences in the parameters for each growth group. A separate model could be estimated for each subgroup. However, if dummy variables are used, the t-ratio for the estimated coefficients of each dummy or interaction variable indicates whether or not that coefficient is significantly different from the corresponding base variable. The model assumes that the intercept and the slope of each coefficient is different for each growth group. The middle growth group is used as a base group. The definitions of UVAL, GDP, POP, and PROD remain the same; however, the estimated parameters on these variables now represent the parameters for the middle growth group. The other variables are defined as follows

HDUM = dummy variable for the high growth group; HDUM = 1 whenever observations from the high group are used and is equal to zero otherwise;

LDUM = dummy variable for the low growth group; LDUM = 1 whenever observations from the low group are used and is equal to zero otherwise;

HUVAL = HDUM x UVAL; (4.15a)

LUVAL = LDUM x UVAL; (4.15b)

HGDP = HMDUM x GDP; (4.15c)

LGDP = LDUM x GDP; (4.15d)

HPOP = HDUM x POP; (4.15e)

LPOP = LDUM x POP; (4.15f)

HPROD = HDUM x PROD; and (4.15g)

LPROD = LDUM x PROD. (4.15h)

The parameters for groups other than the base can be calculated by summing the values of parameters for the base group and the group in question. For example, the intercept for the low growth group is calculated as $\beta_0+\beta_{0L}$ where where β_0 represents the intercept for the base group, in this case the middle growth group.

Hypothesis Testing

The assumption that models estimated for the separate groups would differ from a model estimated for the groups as a whole can be tested using a Chow test. An F test statistic was calculated by

$$F = \frac{[RSS_0 - RSS_1]/(K+1)}{RSS_1/[N_1+N_2+N_3-2(K+1)]} \qquad (4.16)$$

where RSS_0 is the residual sum of squares from the regression on the group as a whole, RSS_1 is the residual sum of squares from the regression using dummy variables, K is the number of independent variables, N_1 is the number of observations in Group 1, N_2 is the number of observations in Group 2, and N_3 is the number of observations in Group 3. If the $F > F_{K+1,\ N1+N2-2(K+1)}$, a different model applies across groups.

A two-tailed t test can be used to determine whether the parameter on one variable is significantly different from the parameter on another variable. In this study, t tests were used to determine whether the parameters for the high and low growth groups are significantly different from each other. Tests were conducted for the slope and for each independent variable with the hypothesis as

$$H_o\colon\ \beta_{kL}=\beta_{kH} \qquad (4.17a)$$

$$H_a\colon\ \beta_{kL}\neq\beta_{kH} \qquad (4.17b)$$

The t ratio is calculated as $t = \frac{\beta_{kL}-\beta_{kH}}{s_{\beta kL}}$ where s is the standard error of the estimated coefficient. If $|t|>t_{\alpha/2,\nu}$ where α represents the confidence interval and ν represents the degrees of freedom in the regression equation, then the null hypothesis is rejected in favor of the alternative hypothesis.

Chapter Summary

Chapter IV introduced the theoretical and behavioral econometric models used in the empirical estimations of agricultural import demand for twelve of the fifteen largest agricultural import markets. The cross-sectionally heteroskedastic and timewise autoregressive model used for the empirical estimations of the behavioral model was presented. The selection and categorization of countries included in the study is defined. Two behavioral models for estimating agricultural import demand in the group of countries as a whole and as categorized by growth rates were also presented. The first behavioral model estimated agricultural import demand for the group of countries as a whole. The second model utilized dummy variables to capture differences in estimated parameters between groups. The models were estimated using cross-sectional time series data from the selected countries for 1974 through 1990. Statistical tests used in the analysis of the estimated coefficients were discussed. The data sources and definitions of data concluded the chapter.

CHAPTER V

EMPIRICAL RESULTS AND CONCLUSIONS

Chapter V reports estimates obtained from the empirical analysis of the models presented in Chapter IV. The results of hypothesis tests are reported. Also, the implications of the empirical estimates with respect to the objectives given in Chapter I are discussed.

Estimates for Aggregated Groups Import Demand Model

The index for total agricultural import volume (IMPORT) was regressed against indices for import unit value (UVAL), real gross domestic product (GDP), population (POP), and domestic production volume (PROD) to estimate a total agricultural import demand equation for the study group as defined in Chapter IV. Country groupings are given in Table V. A linear model, a double log model, and a log-linear model were estimated for the data set. The linear model was chosen for the study because the resulting statistical measures indicated a better fit of the model to the data set. Table VI contains the results for this aggregated model, along with the results for the import demand model which allows for different parameters among growth groups.

The estimated linear model for the aggregated groups is

$$IMPORT_t = -1367.3 - 0.37114\ UVAL_t + 2.6218\ GDP_t + 11.711\ POP_t + 1.0938\ PROD_t \tag{5.1}$$

TABLE V

COUNTRY GROUPINGS OF LARGE AGRICULTURAL IMPORT MARKETS AS DETERMINED BY AVERAGE ANNUAL AGRICULTURAL IMPORT GROWTH RATES FROM 1984-1989

Growth Group	Country	Growth Rate (%)	1989 Market Size ($100,000)
High	China	15.74	110748
	Hong Kong	12.50	62933
	Italy	11.16	218627
	Japan	10.17	290595
	France	10.00	198239
Middle	Netherlands	9.20	155810
	Fed. Rep. Germany	8.90	308603
Low	Belgium-Luxembourg	8.42	107980
	United Kingdom	8.32	200020
	Egypt	6.19	50050
	Canada	5.55	64095
	United States	2.02	250658

Source: FAO Trade Yearbook.

The t ratios of the aggregated model indicate that all parameter estimates are statistically significant at 5 percent or less. The signs on the coefficients are consistent with economic theory with the exception of production, which is discussed in a later section. All interpretations of coefficients assume ceteris paribus conditions. The coefficient for UVAL indicates that a 1 point increase in the import unit value index will decrease total agricultural imports by approximately .37 percent of the base year import volume. The GDP coefficient indicates that a 1 point increase in the gross domestic product index will lead to

TABLE VI

ESTIMATED COEFFICIENTS FOR AGRICULTURAL IMPORT DEMAND IN LARGE AGRICULTURAL MARKETS, 1974-1990 IN AGGREGATE AND BY HIGH AND LOW IMPORT GROWTH GROUPS

																Statistical Measures		
MODEL	Constant	UVAL (Price)	GDP (Income)	POP (Population)	PROD (Supply Factors)	DUMH (Intercept)	DHVAL (Price)	DHGDP (Income)	DHPOP (Population)	DHPROD (Supply Factors)	DUML (Intercept)	DLVAL (Price)	DLGDP (Income)	DLPOP (Population)	DLPROD (Supply Factors)	R2	Standard Error	Degrees of Freedom
Aggregated Model	-1367.30 (-3..43)**	-0.37 (-2.76)**	2.62 (3.78)**	11.71 (2.59)**	1.09 (1.82)**											.51	0.605	199
Growth Groups Model																.75	0.299	189
Middle Growth Group (Base)	-455.17 (-1.27)	0.1163 (0.487)	0.1869 (0.121)	3.2138 (0.837)	2.6426 (2.072)**													
High Growth Group						165.93 (0.277)	-0.2749 (-0.85)	2.0911 (1.22)	-6.1955 (-0.999)	2.5889 (1.617)*								
Low Growth Group											-966.65 (-1.451)*	-1.3577 (-3.369)**	11.339 (4.562)**	3.852 (0.476)	-5.1725 (-2.726)**			
<u>Final Coefficients</u>																		
High Growth Group						-289.24 (-0.604)	-0.159 (-0.729)	2.278 (3.016)**	-2.982 (-0.613)	5.232 (5.402)**								
Low Growth Group											-1421.8 (-2.532)**	-1.241 (-3.82)**	11.526 (5.903)**	7.066 (0.992)	-2.53 (-1.80)**			

t-values are reported in parentheses below the coefficient estimate.
*significant at 10%
**significant at 5% or less
Dependent Variable: IMPORT = Agricultural Import Volume Index

a 2.6218 percent increase in imports from the base year. One index point increase in population will lead to an increase in agricultural imports of 11.71 percent as measured from the base year, 1974. If production increases by 1 index point, the PROD coefficient indicates that agricultural imports will increase by roughly 1.09 percent of the base. The R^2 between the observed and predicted dependent variable, agricultural import volume, is 0.51 for the aggregated groups model, indicating that approximately 51 percent of the variation in agricultural import volume is explained by the independent variables included in the model. The Durbin-Watson statistic for the model is not reported because the cross-sectionally heteroskedastic and timewise autogressive model employed in the econometric estimations transforms the data to remove autocorrelation, as discussed in Chapter IV.

Estimates for Growth Groups: Import Demand Model

The model presented in Equation 4.15 was estimated to determine differences in coefficients on independent variables for the high and low import growth groups. The index for agricultural import volume was regressed against indices for import unit value (UVAL), gross domestic product (GDP), population (POP), and domestic agricultural production (PROD), along with dummy variables to represent the difference in the intercept term for the high growth group (DUMH) and the low growth group (DUML). Dummy interaction variables (DHVAL, DHGDP, DHPOP, DHPROD, DLVAL, DLGDP, DLPOP, and DLPROD) as defined in Chapter IV were also included to capture differences in coefficients on the independent variables for the high and low growth groups.

The middle growth group (which contains only two countries) was used as a base for the regression so that the high and low groups (which contain five countries each) could be more easily compared. Regression results are summarized in Table VI. The coefficient values obtained in the regression are presented first. The t ratios calculated for the dummy variables and dummy interaction variables should only be used in determining whether the variables are significantly different from the constant. Because the dummy interaction variables capture only the difference in the actual coefficient from the coefficient for the base group, the coefficient estimates for the high and low groups can be obtained by adding the appropriate dummy interaction variable to the appropriate base coefficient. These computed coefficients are also reported in Table VI. The computed coefficients are equal to the coefficients estimated when separate regressions are run for each group. Tests for significance of the computed coefficients are calculated in a later section. The model has an R^2 of .745 which indicates that the model explains approximately 74.5 percent of the variation in agricultural import volume.

<u>High Growth Group</u>

The estimated equation for the high growth group can be written as

$$IMPORT_t = -289.24-0.15867UVAL_t+2.278GDP_t- \qquad (5.2)$$

$$2.2780POP_t+5.2315PROD_t.$$

The effects of changes in variables are interpreted assuming that other variables are held constant. The signs of computed coefficients are as expected for import unit value (UVAL) and gross domestic product (GDP); however, the signs for domestic agricultural production (PROD) and population (POP) are not as expected. An increase of 1 index point in the import unit value index (UVAL) would decrease agricultural import volume by .159 percent as measured from the base year of 1974. Gross domestic product (GDP) has a

positive effect on agricultural import volume, with a 1 index point increase in GDP leading to a 2.278 percent increase from the base in imports. If population increases by 1 index point, the coefficient estimate would indicate that agricultural import volume decreases by 2.982 percent of the base.
An increase in domestic production volume of 1 index point will increase agricultural import volume by 5.232 percent of the base volume.

Low Growth Group

The equation for the low growth group is estimated as

$$IMPORT_t = -1421.84-0.92403UVAL_t+11.5262GDP_t+ \qquad (5.3)$$
$$7.0663POP_t-2.5299PROD_t$$

The signs for all coefficients for the low growth group are consistent with the expectations drawn from economic theory. The coefficients are interpreted separately ceteris paribus. An increase in import unit value (UVAL) of 1 index point will lead to a decrease of agricultural import volume of 1.241 percent from the base year. The coefficient on gross domestic product (GDP) indicates that a 1 point increase in the GDP index will increase import volume 11.526 percent from the base volume. An increase of 1 index point in population (POP) implies an increase of 7.066 percent from the base year's import volume. An increase of 1 index point in domestic agricultural production will lead to a decrease in agricultural import volume of 2.53 percent of the base volume.

Significance Testing

There are two methods used to determine if the group of dummy variables and dummy interaction variables contribute to the explanation of the variation in can be conducted. The R^2 for the model improves from .51 to .74 when dummy variables and dummy interaction variables are used to capture the effects of each group on import volume. The F test statistic can be calculated as shown in Chapter IV. The hypotheses are:

$$H_o\text{:DUML=DLVAL=DLGDP=DLPOP=DLPROD=DUMH=DHVAL} \quad \text{=DHGDP=DHPOP=DHPROD=0} \tag{5.4a}$$

$$H_A\text{:DUML=DLVAL=DLGDP=DLPOP=DLPROD=DUMH=DHVAL=} \quad \text{DHGDP=DHPOP=DHPROD}\neq 0 \tag{5.4b}$$

and if $F^* > F_{10,189}$, then the null hypothesis that the dummy variables and dummy interaction variables are equal to zero and contribute nothing to the model is rejected. The F statistic for the comparison of these two particular models is equal to 7.6134 which is significant at less than 1 percent so the null hypothesis is rejected.

The significance of the calculated coefficients for each group can be determined by a two-tailed t test. The hypotheses are

$$H_o\text{: } \beta_{kg}+\beta_k=0 \tag{5.5a}$$

$$H_a\text{: } \beta_{kg}+\beta_k\neq 0 \tag{5.5b}$$

where k represents the independent variable and g represents the growth group. With the exception of production (PROD), the intercept and all calculated coefficients are significantly different from zero for the low growth group at the 5 percent level or less. Significant coefficients in the high growth group include the intercept coefficient, gross domestic production (GDP), and domestic agricultural production (PROD).

It is of interest to determine if the calculated coefficients for the high and low growth groups are significantly different from each other. The hypotheses to be tested are

$$H_o: \beta_{kL}=\beta_{kH} \quad (5.6a)$$

$$H_a: \beta_{kL}\neq\beta_{kH} \quad (5.6b)$$

If $t^* > t_{189}$, then the null hypothesis is rejected in favor of the alternative hypothesis and the coefficient is considered significant. The test was conducted between groups for each independent variable. The intercept and all coefficients with the exception of population (POP) were significantly different between the high and low growth groups at 10 percent or less.

Comparison of High and Low Growth Groups

Agricultural import volume is increasing at higher rates in some markets than in others as illustrated earlier in Table V. It is of interest to determine which import demand variables are significantly different when compared between the high and low growth groups. Table VII reports the results of t tests conducted to determine if the final coefficients for each growth group are significantly different from the corresponding coefficient for the other group. The final coefficients for each group are the sum of the base group coefficient and the corresponding growth group coefficient. Both groups have the same base coefficient so the tests were conducted to determine if the corresponding dummy interaction variables were significantly different from each other. The estimated coefficients for the intercept and independent variables are significantly different at 10 percent or better between the groups, with the exception of population (POP). Specific differences are discussed in the following sections.

TABLE VII

RESULTS OF SIGNIFICANCE TESTING FOR DIFFERENCES BETWEEN HIGH AND LOW GROWTH GROUPS

Variable	Test	Test Value	Standard Error	t-ratio
Intercept	DUML=DUMH	-1132.6	737.75	-1.54*
Import Unit Value	DLVAL=DHVAL	-1.083	0.39	-2.77**
Gross Domestic Product	DLGDP=DHGDP	9.25	2.09	4.42**
Population	DLPOP=DHPOP	10.05	8.63	1.16
Production	DLPROD=DHPROD	-7.76	1.71	-4.55**

*significant at 10 percent
**significant at 5 percent

Effects of Import Unit Value

Import Unit Value (UVAL) has a negative effect on agricultural import volume in both high and low growth groups. The coefficient is highly significant for the low growth group, but is insignificant for the high growth group. This implies that import prices do not affect purchase decisions as much in high growth countries as in low growth countries. Hong Kong and Japan, both high growth countries, have little agricultural land available for production; therefore, import demand is more inelastic in these countries than in low growth countries such as Canada and the United States, who have vast agricultural resources.

Effects of Gross Domestic Product

Gross Domestic Product (GDP) has a positive and significant effect on agricultural import volume in both high and low growth groups. The low growth group exhibits more sensitivity to changes in income than does the high growth group. For example, an increase of 1 index point in GDP leads to a 11.53 percent increase from the base year's imports for the low growth group while the same change in GDP for high growth group increases imports by only 2.28 percent from the base year. This may be partially explained by the fact that developing countries such as China in the high growth group typically import basic food requirements which would be assumed to be relatively income inelastic compared to the broader base of agricultural imports purchased by the more developed countries such as the United Kingdom and the United States.

Effects of Population

The final coefficient for population (POP) in the high growth group carries an unexpected negative sign but is statistically insignificant. The low growth group's final coefficient for population is positive but insignificant. As discussed in Chapter IV, POP was included in the model rather than incorporated as per capita data for GDP and domestic production (PROD) to separate the effects of population from income and production. According to the estimates, the effects of population as a separate parameter on agricultural import volume are negligible in both groups.

Effects of Domestic Production

Domestic production (PROD) is significant for all study groups; however, the sign is not as expected for the high growth and aggregate groups. General economic theory leads to the expectation that increases in domestic production increase domestic supply and therefore decrease the demand for imports. Low growth countries follow this pattern, but high growth and the aggregate do not. One possible explanation is that increased domestic production may act as a demand side rather than supply side variable in some countries by increasing the capacity to export thus increasing the availability of foreign currency for import purchases. In this case, the expected sign for domestic production would be positive as it is for the aggregate and high growth groups. A breakdown of the countries within groups further illustrates this point.

The high growth group includes China, a low-income country that has increased imports greatly in recent periods due to policy changes. Domestic agricultural production in the past has been typically a high-labor, low technology operation, but technological improvements have added efficiency to the agricultural sector. Soybeans are a primary export of China and typically generate foreign currency income used to purchase wheat and rice for use as food. Italy is also in the high growth group. Agricultural land for general use in Italy is not plentiful, but specialty crops such as grapes for wine are produced and other goods are imported, representing a case where domestic goods are not a perfect substitute for imported goods. Increased domestic production may translate to increased import capacity that is not directly captured by increases in GDP.

The low growth group includes Canada and the United States which are agriculturally developed and self-sustainable countries. Agricultural imports, in aggregate, are considered perfect substitutes for domestic goods. In this situation it is expected that domestic production would follow economic theory and be negatively related to imports.

Impacts of Other Market Characteristics

The countries included in the high and low growth groups have other characteristics that may affect their behavior in the import market. Net importers may behave differently than net exporters though both might fall into the same growth group. Also, countries who are members of the same free trade area may behave differently than non-members. The following sections contain a brief discussion of the impact of these characteristics on the reactions of countries to changes in the market factors that affect agricultural import demand.

Comparison of Net Importers and Net Exporters

Markets that rely heavily on agricultural imports may react differently to changes in market factors than markets that are typically net exporters of agricultural products. The following comparison of net importers and net exporters of agricultural products presents the impacts of import demand variables on these markets. The estimation technique is comparable to the growth groups model with dummy and dummy interaction variables used to measure coefficient differences for net exporters. Net importers were used as the base group for the estimations. The classification of markets in Table VIII as net importers or net exporters was determined by subtracting total agricultural imports from total agricultural exports for the years 1985 through 1989 and calculating an annual average of net exports. Countries with negative net exports were considered to be net importers. The resulting equation for net importers was

$$-3045.9-0.48227\,UVAL_t+0.50749GDP_t+22.238POP_t+9.7076PROD_t \quad (5.7)$$

while the resulting equation for net exporters was

$$-430.72-0.51722UVAL_t+6.3458GDP_t+0.49434POP_t-0.86922PROD_t \quad (5.8)$$

as reported in Table IX. The R^2 for the estimated model is .38 which indicates that the model explains 38 percent of the variation in agricultural import volume. Results of significance testing are also reported. The t tests to determine if the coefficients for net importers are significantly different from the coefficients on the corresponding variables for net exporters were conducted as discussed in Chapter IV. The results indicate that the coefficients for import unit value (UVAL) and gross domestic product (GDP) are significantly different between groups at 1 percent.

TABLE VIII

NET AGRICULTURAL EXPORTERS AND NET AGRICULTURAL IMPORTERS AMONG LARGE AGRICULTURAL MARKETS

Net Agricultural Exporters		Net Agricultural Importers	
Country	Average Net Agricultural Exports 1985-1990 ($100,000)	Country	Average Net Agri. Agricultural Imports 1985-1990 ($100,000)
Canada	197416	Egypt	264120
United States	119217	Hong Kong	261202
Netherlands*	86546	Japan	224436
France*	69420	Fed. Rep. Germany*	139654
China	9714	Italy*	113038
		Belgium-Luxembourg*	99444
		United Kingdom*	86100

*European Economic Community Members

Source: FAO Trade Yearbook.

TABLE IX

ESTIMATED COEFFICIENTS FOR AGRICULTURAL IMPORT DEMAND IN LARGE AGRICULTURAL MARKETS, 1974-1990 BY NET IMPORTER/NET EXPORTER AND BY EEC MEMBERS/NON-MEMBERS

											Statistical Measures		
Model	Constant	UVAL (Price)	GDP (Income)	POP (Population)	PROD (Supply Factors)	Intercept (Dummy)	UVAL (Dummy Interaction)	GDP (Dummy Interaction)	POP (Dummy Interaction)	PROD (Dummy Interaction)	R2	Standard Error	Degrees of Freedom
Net Importer/Net Exporter Model											.38	.515	194
Net Importers	3045.9 (-3.89)**	-0.4823 (-1.42)*	0.5075 (0.31)	22.238 (2.60)**	9.7076 (5.95)**								
Net Exporters													
–estimated dummy values						2615.2 (2.76)**	-0.0349 (-0.09)	5.8383 (2.98)**	-21.744 (-2.05)**	-10.577 (-5.93)**			
–final coefficient						-430.72 (-0.80)	-0.5172 (-2.95)**	6.3458 (6.01)**	0.4943 (0.79)	-0.8692 (-1.20)			
EEC Model											.82	0.592	194
Non-EEC Members	-2656 (-2.33)**	-1.1072 (-2.61)**	3.2615 (1.74)**	23.051 (1.78)**	1.4154 (0.88)								
EEC Members													
–estimated dummy values						1484.8 (1.27)	0.8425 (1.93)**	-0.2466 (-0.13)	-14.136 (-1.07)	-0.0066 (-0.004)			
–final coefficient						-1171.2 (-4.67)**	-0.2647 (-2.62)**	3.0149 (6.24)**	8.9151 (3.20)**	1.4089 (2.81)**			

t-values are reported in parentheses below the coefficient estimates
* - significant at 10 percent
** - significant at 5 percent or less
Dependent Variable: IMPORT = Agricultural Import Volume Index
NOTE: t-values on estimated dummy values measure difference from corresponding base group coefficients.

Effects of Import Unit Value

Increases in import unit value affect agricultural import volume negatively in both net importing countries and net exporting countries. The coefficient is negative and significant for both groups. Accordingly, increases in import unit value will lead to a decrease in agricultural import volume for both net importers and net exporters.

Effects of Gross Domestic Product

The coefficient for gross domestic product is positive for both groups but is statistically significant only for net exporters. This suggests that net exporters are more responsive to changes in gross domestic product than net importers are. In general, countries in the net exporting group such as France and the United States are large agricultural producers so basic food needs in these countries can be met without large import quantities. The products imported by these countries may tend to be value-added products or specialty products that have higher income elasticities than basic food grains and staple goods which are likely the products purchased by net importers.

Effects of Population

Changes in population have a significant impact on import purchases of net importers, but the impact on net exporters is insignificant. A possible explanation for the different impact of population on the two groups is that net importers may have limited or underdeveloped agricultural resources. In this situation, any increased demand created by population changes must be met with imports.

Effects of Domestic Production

Domestic production has a positive and significant influence on the volume of agricultural imports for net importers. The coefficient for net exporters is not significant at 10 percent and is negative. Domestic production may have a positive impact in net importing countries because, as discussed earlier, domestic production may become a demand side rather than supply side variable by increasing foreign exchange availability through increased exports. This could be especially true in countries, such as Italy, that produce predominantly specialty products. Domestic production, in effect, becomes an independent income variable and the expected sign becomes positive. Domestic production in net exporting countries is typically a perfect substitute for agricultural imports so increased production would be expected to decrease imports.

Comparison of EEC Members and Non-members

Member countries of the European Economic Community (EEC) as a group form the largest market for agricultural imports in the world. The opening of the internal borders of Europe to free trade is seen by many outsiders as a great opportunity and by some as a threat. The following section examines the differences that market variables have on import demand in EEC members and non-EEC members in the study group. Again, the model was estimated with the same method as the growth groups model with dummy and dummy interaction variables used to estimate coefficient differences for the EEC members. Non-EEC members were used as the base group. The equation for non-EEC members was estimated as

$$-2656-1.1072UVAL_t+3.2615GDP_t+23.051POP_t+1.4154PROD_t \qquad (5.9)$$

and the estimated equation for EEC members is

$$-1171.2-0.2647UVAL_t+3.0149GDP_t+8.9151POP_t+1.4089PROD_t \qquad (5.10)$$

The R^2 for the total model is .82 indicating that 82 percent of the variation in agricultural imports is explained by the model. Differences in coefficients were determined by conducting t tests as described in Chapter IV. Results of the tests are reported in Table IX. Only import unit value (UVAL) was significantly different between the groups at 10 percent or less.

Effects of Import Unit Value

The coefficient for import unit value is negative and significant for both groups. EEC members are less sensitive to changes in import unit value (UVAL) than are non-members. Separately, the members are not self-sufficient in agricultural production. Highly industrialized countries such as Germany and the United Kingdom rely heavily on imports, whether the source of imports is from member countries or non-member countries. This partially explains the import price inelasticity of the EEC countries.

Effects of Gross Domestic Product

Changes in gross domestic product (GDP) have the same effect in both EEC members and non-members. An increase in gross domestic product will lead to an increase in agricultural import volume. The estimated coefficient is positive and significant for both groups, but the magnitude of the impact is not significantly different between groups.

Effects of Population

Population changes (POP) also impact EEC members and non-members in the same way with respect to agricultural imports. Increases in population will induce increases in import volume. The coefficient is positive and significant for both groups. Again, the magnitude of the impact is not significantly different between groups.

Effects of Production

The coefficient for domestic production (PROD) is positive for both groups, but is significant only for EEC members. As mentioned earlier, many members of the EEC are not self-sufficient agriculturally when considered individually. This could affect their behavior with respect to domestic production. Increases in domestic production may have an agricultural income effect, not captured by gross domestic product, that affects the demand for agricultural imports included in the dependent variable. Through this income effect, increased domestic production will lead to increased agricultural imports.

Effect of Internal Factors

Import demand behavior may vary by country groupings and within countries because of internal factors not considered in this study. The aggregation of data from several countries makes it impossible to include such factors as government policies, economic development stages, technological differences, and degree of agricultural sustainability. Other factors not measured in this study are the distribution of income and purchasing power and the availability of credit to governments.

High import growth rates may not be sustainable over time because of the influence of population and income. If these factors increase at a slower rate than current import growth rates, then import growth must also decrease over time. The behavior of EEC members may change as the economic union of the individual countries solidifies. Over time, net importers with underdeveloped agricultural resources could become net exporters and their behavior may change accordingly. All of these changes would change the implications of the estimated equations.

Implications for the Future

For U.S. agriculture, searching for methods to increase exports is an ongoing business. The strategy of marketing, whether in domestic markets or abroad, is to find and create customers. Once customers are discovered or created, the marketer must be attentive to the customer's needs in order to maintain or increase sales volume. This strategy has specific implications in U.S. export marketing policy and for U.S. agriculture in general.

Policy Implications

Targeting large markets where agricultural import markets are growing at high rates may be a task deserving of pursuit. This study indicates that increased domestic production and gross domestic product have significant positive impacts on agricultural imports in countries with high rates of import growth; this has interesting implications for U.S. policy toward both developing and developed countries in the high growth group. Development assistance in underdeveloped countries with high rates of agricultural import growth would be beneficial to the U.S. in two ways. First, specific development assistance in the production agriculture sector in non-competing commodities would increase domestic agricultural production and would likely increase gross domestic product, too. Improvements in the production agriculture sector are likely to improve the marketing chain from producer to consumer, thus improving the infrastructure. Development assistance in high growth countries with a small agricultural resource base could be implemented in other sectors of the economy. The resulting repercussions on agricultural import demand variables should be the same. Second, development assistance from the U.S. is likely to create customer loyalty. An increase in agricultural imports in these countries does not necessarily mean increased exports for the U.S. since there are competing producers of agricultural products. However, countries would possibly purchase a greater percentage of increased imports from the U.S. if development assistance is provided.

The integration of the European Economic Community could have positive impacts on agricultural imports to member countries. The European Community Commission has carried out numerous economic studies, both internally and with outside consultants, that suggest full integration of the European market will lead to increases in gross domestic product of as much as 7 percent for member countries (Quelch, 1991). Increases in gross domestic product have a significant impact on agricultural imports for both high and low growth countries and for EEC member countries. Four of the six EEC members included in the study group fall into either the high or low growth group. This does not necessarily imply that agricultural imports to EEC members from non-members will increase because the study does not consider the source of the product, but it is reasonable to assume that the United States could increase total agricultural exports to the EEC by maintaining or increasing the current U.S. share in those markets. Typically, as income increases, so does the demand for high-value and processed products (HVP's). Though the EEC is a fierce competitor of the U.S. in the HVP export market, they also offer an import market for specialty high value and processed products from the U.S. Accordingly, increased emphasis on the marketing of HVP's to the EEC could conceivably increase U.S. agricultural exports to the region.

Non-EEC members are more sensitive to changes in import unit value than are EEC members. In 1989, the United States held 34 percent of the agricultural import market in Canada. The North American Free Trade Agreement (NAFTA) could potentially lower prices and increase U.S. agricultural exports to Canada, particularly in exports of fruits, vegetables, and HVP's.

Other Implications

U.S. policy cannot effectively control or influence the market variables of agricultural import demand in particular situations. For example, the low growth group and non-EEC members are both highly responsive to changes in import unit value. Though the U.S. is a large exporter of many agricultural products, the world price cannot be greatly affected by one producer in most product markets. Global production will dictate the world price at which commodities are sold. Thus the U.S. has little control over price in most markets.

Agricultural import demand in low growth countries and in net exporters is responsive to changes in gross domestic product. If low growth countries are typically developed countries, then U.S. agricultural exports depend partially on the internal economic growth of those countries.

Net importers' agricultural imports are very sensitive to fluctuations in domestic agricultural production and, therefore, are partially dependent on internal policies which protect or stabilize production. Ironically, the U.S. criticizes price supports and subsidies in other countries or trading blocks, but the results of this study indicate that more stable domestic production in net importers will result in increased agricultural exports to those countries.

Agricultural import demand in net importing countries is affected greatly by changes in population. The increased global awareness of overcrowding could impact future growth rates in population and in agricultural import demand as more countries encourage or enforce smaller family sizes.

Suggestions for Further Research

A large amount of money is spent each year on the promotion of U.S. agricultural products in foreign markets. Export promotion is not only used for creating demand in new markets, but also for maintaining or increasing demand in existing markets. A useful continuation of this research would be to overlap market promotion expenditures with statistics on U.S. market shares in growth markets to determine the effectiveness of promotion. If the U.S. maintains or increases market share in a growing market, an increase in total U.S. agricultural exports to that market will result. Foreign aid to developing countries is an indirect, long-term method of export promotion and is a large proportion of annual expenditures. Information on the effectiveness of foreign aid in developing future markets for U.S. agricultural products would be valuable to policymakers.

As mentioned earlier, the commodity composition of agricultural trade was not considered in this study. An analysis of the composition of rapidly growing markets' imports versus that of large markets' imports would be valuable information for exporters.

Summary

The primary objective of the study was to determine if import demand variables have significantly different impacts on agricultural import demand in large agricultural import markets when different rates of growth in agricultural imports exist. Four specific objectives were defined. First, global trends in agricultural import demand were reviewed for 1984 through 1989 in Chapter I. Rates of import growth were compared across geographical and economic regions. Countries were grouped into five categories by market size: (1) all countries, (2) large markets, (3) medium markets, (4) small markets, and (5) very small markets. Within each category, countries were compared by absolute change in imports, average annual rates of import growth, and total rate of import growth during the time period. Then the U.S. market share of agricultural imports was compared in the 15 largest markets and the 15 fastest growing markets.

The second objective was to review the existing literature on the estimation of single and multiple commodity models of import demand and of export demand. Chapter II reviewed several behavioral models of import demand for both agricultural and non-agricultural commodities. Multiple product import demand studies were presented first, followed by a discussion of single product import demand studies. Chapter II concluded with a discussion of export demand studies.

The third objective was to review the economic theory underlying import demand and demand elasticities. In Chapter III, the role of trade in the economy was discussed with a review of comparative advantage. Then import demand theory was presented with a discussion of the domestic demand and supply functions which are considered the foundation for import demand when imported goods are considered perfect substitutes for domestic goods. Common elasticity measurements with respect to import demand were also presented.

The fourth objective was to econometrically estimate agricultural import demand functions for the study group, as a whole and in groups classified by average annual growth rates of agricultural imports, in order to determine if significant differences exist in the impact of import demand variables on growth groups. This is achieved in Chapters IV and V. The methodology used in the empirical estimation of the import demand function was presented in Chapter IV. A thorough discussion of the implied assumptions and techniques used in estimated pooled cross-sectional time series data was given. Data sources were reported, along with definitions of data used in the study. Chapter V reported the estimated agricultural import demand models and the results of statistical tests for the model. The parameters for the high growth group and low growth group were statistically compared and possible reasons for differences in those parameters were discussed.

Conclusions

Agricultural import demand in large agricultural markets follows the expected behavioral model, with the exception of the coefficient for domestic production, which is positive. Each estimated coefficient is significant at 5 percent or less.

High and low growth subgroups have significantly different parameters for import unit value, gross domestic product, domestic production, and the intercept. Agricultural import demand for the low growth group is more responsive to changes in import unit value and gross domestic product than the high growth group. Domestic production has an unexpected positive relationship with agricultural import demand in the high growth group. The high growth group's agricultural import demand is more sensitive to changes in domestic production than the low growth group.

Net exporters have significantly different parameters from net importers for gross domestic product, population, domestic production, and the intercept. Domestic production has a negative relationship with agricultural import demand for net importers. Agricultural import demand of net importers is more responsive to changes in population and domestic production than that of net exporters. Net exporters' agricultural import demand is more responsive to changes in import unit value than net importers' demand.

Import unit value is the only coefficient that is significantly different between EEC members and non-members. Non-members are more sensitive to changes in import unit value than EEC members.

Import unit value, gross domestic product, population, and domestic production affect agricultural import demand in different magnitudes when compared between high and low growth groups, net importers and net exporters, and EEC members and non-members. The results of the study suggest that a strategy to increase agricultural import demand in one subgroup may have no effect or possibly even the opposite of the desired effect if used for another subgroup. This implies that for export marketing strategies to be successful, they should be tailored for a targeted group of countries by considering the relationship of the market variables that affect agricultural import demand in that group.

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APPENDIX

Limitations of the Study

Results of the study should not be inferred to countries outside of the study group. Other limitations of the study are discussed in the following paragraphs.

Aggregation Across Agricultural Products

The aggregation of all agricultural products made the measurement of import volume impossible without the use of an index. Using an index for volume measurement complicates the interpretation of the results. It is difficult to translate an increase in the import volume index to a measured increase in imports because the base import volume is different for each country. Also, the nature of the study does not allow for an analysis of the commodity composition of agricultural imports in the countries studied. Details about the composition of imports and the import growth rates of those particular products in the countries would be useful in determining which U.S. agricultural products have the greatest potential for capturing the growth in those markets.

Aggregation Across Countries

The aggregation of several countries with differences in trade policies, economic development stages, agricultural resource bases, income distributions and other factors which affect agricultural import demand creates a study group which is non-homogeneous.

Use of Proxies

Domestic production was used as a proxy in measuring supply-side variables for the import demand equation. This was necessary because of a lack of accurate and comparable source of data across countries.

Interpretation of Coefficients

Using index numbers rather than actual figures for the independent variables both simplified and complicated the interpretation of the resulting coefficients. Changes in the coefficient represent a percentage change in the agricultural import volume base resulting from a 1 percent change in the base of the corresponding variable. Consequently, obtaining the actual change in figures is difficult because the same index base of 100 for each independent variable is a different price, income, population, or production figure for each country.

DATA USED IN ESTIMATION OF MODELS

	Year	Total Agri. Imports[1]	Import Unit Value[1]	Gross Domestic Product[2]	Population[3]	Domestic Agri. Production[3]
China	1974	100.00	100.00	100.00	100.00	100.00
	1975	178.28	123.97	108.27	101.90	102.21
	1976	211.60	150.68	102.42	103.64	101.65
	1977	264.82	186.31	110.47	105.22	102.12
	1978	339.72	213.79	124.32	106.69	111.47
	1979	144.86	285.49	133.02	108.09	118.29
	1980	220.93	389.00	141.53	109.47	120.20
	1981	374.04	420.24	148.47	110.82	125.10
	1982	247.26	428.58	160.79	112.16	136.31
	1983	299.77	440.23	176.55	113.51	144.46
	1984	581.73	357.75	200.06	114.93	157.90
	1985	1308.61	187.10	225.02	116.43	159.01
	1986	465.95	245.15	242.71	118.03	162.49
	1987	345.03	419.37	267.10	119.72	171.22
	1988	960.17	281.58	293.49	121.49	176.00
	1989	2114.05	282.72	302.75	123.32	180.94
	1990	2036.37	299.12	326.16	125.17	191.48
Hong Kong	1974	100.00	100.00	100.00	100.00	100.00
	1975	99.43	111.16	108.27	101.76	83.85
	1976	111.84	115.81	102.42	102.87	77.21
	1977	118.44	138.39	110.47	103.59	87.55
	1978	138.16	133.89	124.32	105.52	78.28
	1979	132.59	168.96	133.02	111.44	94.08
	1980	157.26	208.41	141.53	114.47	81.14
	1981	162.22	205.25	148.47	117.16	98.51
	1982	216.95	214.92	160.79	118.99	83.50
	1983	279.37	211.05	176.55	120.82	74.31
	1984	224.65	257.76	200.06	122.02	84.01
	1985	184.99	193.91	225.02	123.33	97.69
	1986	242.66	212.80	242.71	125.05	58.09
	1987	196.91	221.81	267.10	126.90	61.49
	1988	263.52	245.74	293.49	128.41	58.71
	1989	195.37	296.08	302.75	130.24	65.56
	1990	166.08	304.20	326.16	132.26	68.16

[1]Source: FAO Trade Yearbook
[2]Source: World Bank World Tables
[3]Source: FAO Production Yearbook

	Year	Total Agri. Imports[1]	Import Unit Value[1]	Gross Domestic Product[2]	Population[3]	Domestic Agri. Production[3]
Italy	1974	100.00	100.00	100.00	100.00	100.00
	1975	72.18	98.89	97.35	100.60	102.82
	1976	133.16	102.73	103.75	101.10	98.71
	1977	129.38	137.11	107.26	101.53	102.27
	1978	229.91	112.75	111.20	101.89	102.16
	1979	251.33	145.78	117.86	102.19	107.12
	1980	217.91	189.17	122.86	102.40	113.83
	1981	252.08	210.17	124.03	102.53	113.16
	1982	252.92	194.24	124.44	102.77	110.59
	1983	273.82	194.26	125.84	103.13	120.45
	1984	256.74	199.58	129.82	103.44	111.08
	1985	286.58	156.69	133.32	103.68	112.70
	1986	270.19	184.26	136.74	103.87	112.37
	1987	328.08	206.57	140.85	104.05	116.02
	1988	270.02	262.76	146.79	104.25	111.91
	1989	290.48	263.41	151.43	104.41	114.28
	1990	340.11	240.33	156.34	104.55	107.21
Japan	1974	100.00	100.00	100.00	100.00	100.00
	1975	65.16	81.11	102.59	101.24	106.37
	1976	113.82	108.33	107.50	102.37	96.53
	1977	135.39	156.73	113.18	103.36	104.33
	1978	118.03	142.18	118.95	104.30	101.11
	1979	115.84	177.33	125.12	105.18	98.77
	1980	107.17	237.78	103.68	106.01	88.86
	1981	102.85	256.06	135.73	106.80	90.37
	1982	91.53	210.21	139.48	107.52	91.68
	1983	129.99	225.27	143.98	108.26	91.00
	1984	113.65	226.53	150.87	108.95	98.50
	1985	209.98	138.68	157.89	109.62	99.05
	1986	170.13	190.16	161.96	110.29	98.56
	1987	149.00	220.45	168.51	110.83	94.26
	1988	266.08	283.14	177.77	111.30	89.83
	1989	255.60	283.48	186.51	111.76	91.34
	1990	268.96	285.01	194.45	112.13	90.79

[1]Source: FAO Trade Yearbook
[2]Source: World Bank World Tables
[3]Source: FAO Production Yearbook

	Year	Total Agri. Imports[1]	Import Unit Value[1]	Gross Domestic Product[2]	Population[3]	Domestic Agri. Production[3]
France	1974	100.00	100.00	100.00	100.00	100.00
	1975	102.46	97.86	99.72	100.46	93.83
	1976	128.15	107.27	103.95	100.85	95.28
	1977	128.03	141.82	107.30	101.31	89.06
	1978	196.76	127.21	110.89	101.75	95.86
	1979	198.04	164.27	114.49	102.18	105.08
	1980	187.77	214.75	116.35	102.71	105.53
	1981	214.77	237.77	117.72	103.28	102.28
	1982	235.12	211.27	120.71	103.85	109.18
	1983	194.97	237.39	121.55	104.33	104.41
	1984	182.68	233.95	123.14	104.74	113.95
	1985	220.40	185.91	125.51	105.17	111.51
	1986	241.00	214.44	128.45	105.59	110.95
	1987	267.57	227.08	131.57	106.04	113.89
	1988	259.84	282.83	136.68	106.53	110.52
	1989	252.89	287.68	141.74	107.05	107.14
	1990	260.98	272.76	146.12	107.52	107.72
Netherlands	1974	100.00	100.00	100.00	100.00	100.0
	1975	117.95	109.71	99.45	100.83	102.66
	1976	150.98	121.28	104.43	101.68	99.59
	1977	173.44	132.28	107.10	102.31	101.44
	1978	209.56	126.87	109.72	102.93	107.35
	1979	200.52	182.46	111.98	103.62	109.67
	1980	216.53	241.35	113.27	104.45	110.44
	1981	259.41	233.60	112.45	105.21	123.26
	1982	319.59	213.10	110.81	105.69	124.93
	1983	260.59	246.20	112.29	106.07	122.64
	1984	290.85	229.52	115.59	106.50	126.07
	1985	358.44	198.67	118.41	106.98	124.17
	1986	308.18	251.57	121.62	107.56	136.49
	1987	307.82	278.92	123.00	108.29	132.41
	1988	332.20	285.91	126.62	109.00	130.00
	1989	201.04	302.22	132.04	109.62	141.17
	1990	343.99	314.60	135.69	110.42	144.21

[1]Source: FAO Trade Yearbook
[2]Source: World Bank World Tables
[3]Source: FAO Production Yearbook

	Year	Total Agri. Imports[1]	Import Unit Value[1]	Gross Domestic Product[2]	Population[3]	Domestic Agri. Production[3]
Fed. Rep.	1974	100.00	100.00	100.00	100.00	100.00
of Germany	1975	115.15	107.91	98.42	99.64	97.18
	1976	149.65	118.66	103.75	99.16	95.74
	1977	176.21	137.26	106.80	98.95	100.29
	1978	233.33	135.59	109.87	98.83	104.42
	1979	244.58	185.14	114.43	98.88	104.14
	1980	249.67	235.95	115.99	99.21	106.61
	1981	265.65	246.00	116.18	99.40	106.04
	1982	297.97	228.08	115.43	99.33	114.38
	1983	294.86	246.36	117.18	98.98	111.73
	1984	281.84	234.55	120.39	98.58	118.61
	1985	272.54	193.16	122.84	98.34	114.19
	1986	234.17	240.39	125.62	98.41	122.41
	1987	237.23	262.64	127.93	98.43	116.60
	1988	225.23	305.06	132.64	98.98	120.57
	1989	212.18	313.84	136.09	99.90	119.64
	1990	197.77	320.34	139.62	101.31	119.20
Belgium-	1974	100.00	100.00	100.00	100.00	100.0
Luxembourg	1975	107.07	106.97	98.60	100.32	86.59
	1976	143.84	119.13	108.18	100.49	82.40
	1977	150.54	136.06	108.84	100.62	87.42
	1978	176.07	131.56	112.00	100.72	86.96
	1979	171.78	183.46	114.42	100.82	92.55
	1980	168.01	241.88	119.03	100.94	90.62
	1981	183.77	234.57	117.94	100.95	97.28
	1982	218.48	218.21	119.68	100.93	94.63
	1983	197.21	237.42	120.26	100.92	90.39
	1984	182.01	236.95	122.97	100.93	99.03
	1985	189.02	195.19	124.15	100.96	99.68
	1986	166.23	244.51	125.57	101.01	108.31
	1987	185.41	319.94	134.52	101.45	108.34
	1988	176.42	319.94	134.62	101.45	108.34
	1989	210.87	310.72	140.24	101.41	109.38
	1990	204.55	329.24	144.58	101.22	111.36

[1]Source: FAO Trade Yearbook
[2]Source: World Bank World Tables
[3]Source: FAO Production Yearbook

	Year	Total Agri. Imports[1]	Import Unit Value[1]	Gross Domestic Product[2]	Population[3]	Domestic Agri. Production[3]
United Kingdom	1974	100.00	100.00	100.00	100.00	100.00
	1975	100.54	91.00	99.07	99.99	94.95
	1976	119.56	102.68	102.01	99.97	89.75
	1977	104.12	142.44	104.32	99.93	100.51
	1978	129.37	142.84	108.12	99.91	102.31
	1979	165.25	188.62	111.16	100.02	105.54
	1980	165.36	229.02	108.72	100.18	112.07
	1981	312.89	223.65	107.32	100.22	110.36
	1982	464.74	211.78	109.17	100.14	113.59
	1983	362.74	233.19	113.00	100.21	114.91
	1984	295.24	222.71	115.40	100.41	125.88
	1985	317.44	189.93	119.65	100.69	120.62
	1986	325.85	229.28	124.00	100.95	120.15
	1987	321.06	257.46	129.82	101.25	118.75
	1988	312.85	311.94	135.70	101.49	116.02
	1989	298.33	307.24	138.85	101.80	120.02
	1990	362.66	287.28	144.12	101.80	120.84
Egypt	1974	100.00	100.00	100.00	100.00	100.00
	1975	159.10	159.12	110.11	102.01	011.04
	1976	483.16	191.40	127.11	104.24	103.62
	1977	415.77	200.57	143.71	106.67	100.83
	1978	760.73	190.70	154.74	109.28	104.64
	1979	142.82	154.19	166.96	112.03	108.40
	1980	498.25	159.24	185.01	114.90	109.52
	1981	1049.07	234.48	192.35	117.90	113.06
	1982	1590.70	193.34	212.90	121.00	119.55
	1983	1732.39	220.79	229.29	124.20	124.65
	1984	3311.27	207.29	243.26	127.46	127.39
	1985	3847.66	181.78	259.32	130.75	137.89
	1986	3902.76	219.76	266.18	134.05	144.90
	1987	3119.49	183.06	272.89	137.36	150.60
	1988	3716.79	244.76	283.59	140.68	155.19
	1989	2652.62	270.42	290.35	144.02	155.45
	1990	3723.21	224.05	298.68	147.38	160.99

[1]Source: FAO Trade Yearbook
[2]Source: World Bank World Tables
[3]Source: FAO Production Yearbook

	Year	Total Agri. Imports[1]	Import Unit Value[1]	Gross Domestic Product[2]	Population[3]	Domestic Agri. Production[3]
Canada	1974	100.00	100.00	100.00	100.00	100.00
	1975	110.08	99.24	102.60	101.48	110.81
	1976	124.25	120.78	108.92	102.81	123.78
	1977	122.50	154.70	112.86	103.95	123.86
	1978	145.17	153.23	118.02	105.18	127.39
	1979	161.18	190.26	122.59	106.23	115.91
	1980	147.16	206.04	124.41	107.42	124.32
	1981	140.50	243.65	128.98	108.87	135.66
	1982	144.31	227.62	124.83	109.91	144.89
	1983	154.43	256.15	128.78	110.76	137.14
	1984	206.10	247.62	136.90	111.82	135.70
	1985	219.54	201.78	143.43	112.53	141.97
	1986	226.39	227.83	147.87	133.30	154.43
	1987	226.02	251.13	154.49	114.51	145.07
	1988	259.92	315.91	162.24	115.82	129.53
	1989	213.96	358.85	166.88	117.23	142.89
	1990	205.43	313.63	173.33	118.42	157.12
United States	1974	100.00	100.00	100.00	100.00	100.00
	1975	83.10	106.91	98.97	100.99	106.59
	1976	123.70	109.95	103.71	101.96	109.81
	1977	117.03	119.34	108.45	102.99	114.71
	1978	134.70	117.25	114.09	104.08	112.25
	1979	111.37	156.21	116.46	105.24	117.72
	1980	92.78	211.72	116.30	106.50	113.27
	1981	122.47	241.52	118.59	107.61	125.77
	1982	117.81	228.82	115.67	108.73	123.81
	1983	191.83	212.68	119.98	109.79	104.47
	1984	241.61	220.51	128.09	110.82	120.94
	1985	252.57	179.78	132.64	111.89	126.71
	1986	221.32	197.40	136.69	112.98	118.78
	1987	293.67	196.93	141.94	114.06	118.30
	1988	392.59	236.47	148.22	115.08	111.58
	1989	378.11	291.98	152.34	116.01	120.89
	1990	355.93	277.45	157.71	116.54	124.44

[1]Source: FAO Trade Yearbook
[2]Source: World Bank World Tables
[3]Source: FAO Production Yearbook

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