

AN ECONOMETRIC ANALYSIS OF THE
DEMAND FOR BEEF IN JAPAN

by

ALHAMBRA RACHMAN

A thesis submitted to the Graduate Faculty in partial
fulfillment of the requirements for the degree

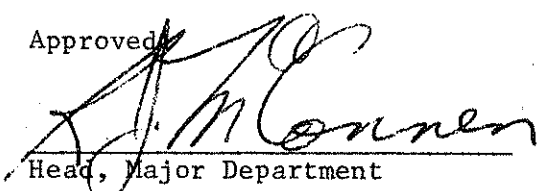
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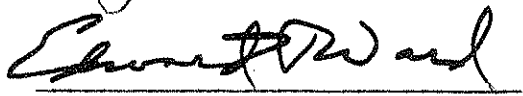
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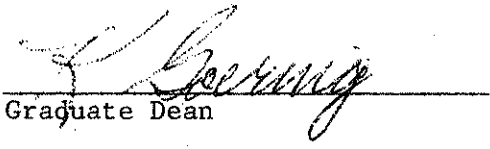
in

Agricultural Economics

Approved


Head, Major Department


Chairman, Examining Committee


Graduate Dean

MONTANA STATE UNIVERSITY
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VITA

Alhambra Rachman was born on May 29, 1932 in Alahan Pandjang, Indonesia.

After completion of the requirements for the M. S. degree in Economics in November, 1964 at the Department of Economics, University of Indonesia, Jakarta, he accepted employment with the Bureau of Social and Economic Studies of the Ministry of Agriculture. In 1968, he was appointed as assistant to the Head of the Planning Bureau of the Ministry of Agriculture. He held this position until he left for the United States in May, 1970 to work toward a Ph.D. program in Agricultural Economics at Montana State University, Bozeman. He expects to receive this degree in June, 1974.

He is married to the former Daria Dahlan, Matur, Indonesia, and has two daughters, Zsi-Zsi and Vivienne, and a son, Reynald.

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ABSTRACT

This study is a quantitative analysis of Japanese beef consumption and prices. It is primarily concerned with the economic analysis of expected changes in domestic prices as a result of changes in imports which Japan could initiate in the near future. In a qualitative framework, an effort was also made to relate the impact of these findings to the Australian beef export sector.

Japan is the only country in the Far East which has achieved a per capita income level and rate of economic growth comparable to the developed countries of the West. However, Japan's per capita beef consumption of 7 pounds in 1971 was among the lowest in the world. More detailed information on Japanese beef demand could indicate the nature of future beef and feed grain prices and trade flows useful to countries of the Far East and around the Pacific area.

A simultaneous econometric model was estimated to account for the interdependence of the beef, pork, and poultry sector. All data were obtained from secondary sources of publications issued by Japanese and United States agencies. The lack of data and other basis information prevented an economic examination of the relationship of beef and fish consumption.

The estimation of the structural parameters was utilized for obtaining both informational results and deriving a reduced form model. The latter was used for predictive purposes and to account for the direct and indirect impacts of the system on the demand for beef.

Barring adverse economic or political circumstances, the structural parameters revealed that the Japanese demand for beef could continue to grow. Within the meat group itself, beef seems to be a more preferred protein source. The income effect appears quite favorable to beef demand as it reflects both purchasing power and tastes. However, its full impact was partially weakened by the prevailing high price level.

At present consumption levels and price ranges, changes in wholesale prices appear relatively inflexible with respect to changes in quantity consumed and income. Predictions on future price movements indicate that the direction of price changes will be primarily determined by the magnitude of future import quotas and continuation of growth in real income.

Expected changes in Japanese import quotas primarily imply liberalized imports. This would exert pressure on Australian export prices and further increase production capacity prospects.

CHAPTER I

INTRODUCTION

Much attention has recently been focused on the world food problem. This interest as well as concern about future food supplies has been directed toward both the less developed countries and the developed countries. For the less developed countries, the food problem is exacerbated by increasing population and the desire to achieve a satisfactory rate of general economic growth. In the developed countries increases in wealth result in a larger absolute amount of income spent on food although at a proportionally declining rate. This results in increasing the demand for preferred or better quality food items. Since meat products are superior food, increases in per capita beef consumption can be expected to continue if per capita income continues to rise.

It is of interest and great need at the present time to look at a wide variety of factors that affect world food production, consumption, and trade. These factors include the natural resource base of nations, the application of science and technology to agriculture, economic and political factors, and the cultural and institutional relationships which condition human behavior in consumption.

World Beef Production, Consumption, and Trade

World production of beef has trended continuously upward during the decade of 1960-1970. Some expect this tendency to hold for the 1970-1980 period. In a study conducted by the Food and Agriculture

Organization of the United Nations, a 3.2 per cent compound rate of growth was estimated for the 1960-1970 period with a projected 2.8 per cent compound rate of growth for the 1970-1980 period. 1/ With the exception of the EC-6 2/ and the United Kingdom, this phenomena can be observed as shown in Table I for the major beef importing countries for the time period 1971-1973.

Expanding consumer demand has resulted in higher prices and new trade patterns in today's world beef trade. Over the period 1971-1973, the EC-6 has shown an average annual increase of 28 per cent in beef and veal imports. The United Kingdom has increased imports by 16 per cent, the United States 8 per cent, and Japan 34 per cent. The primary exporting countries of Australia and Argentina account for over 40 per cent of beef traded in the world market. For Australia exports have increased from 1.3 billion pounds carcass weight equivalent (CWE) in 1972 to a projected 2.1 billion pounds CWE in 1973; while Argentina has increased from 1.1 billion pounds CWE in 1972 to 1.5 billion pounds CWE in 1973. 3/

1/ Food and Agriculture Organization, Agricultural Commodity Projections, 1970-1980, I (Rome, Italy: 1971).

2/ EC-6 is an abbreviation for the countries of Belgium, Netherlands, Luxemburg, France, West Germany, and Italy in the European Economic Community.

3/ Larry E. Stenswick, "World Beef Trade Patterns," Foreign Agriculture, XI, No. 26 (Washington, D. C.: Government Printing Office, 1973), p. 7.

TABLE I. BEEF PRODUCTION AND IMPORTS OF SELECTED MAJOR IMPORTING COUNTRIES.

Country	Year	Production	Imports
		-----Bil. Lbs. CWE-----	
EC-6 <u>a/</u>	1971	9.7	1.0
	1972	8.8	1.5
	1973 <u>b/</u>	9.1	1.6
UK <u>a/</u>	1971	2.1	0.9
	1972	2.0	1.1
	1973 <u>b/</u>	2.1	1.2
US <u>a/</u>	1971	22.4	1.8
	1972	22.9	2.0
	1973 <u>b/</u>	22.9	2.2
Japan <u>c/</u>	1971	0.61	0.09
	1972	0.65	0.13
	1973 <u>b/</u>	0.71	0.22

a/ Larry E. Stenswick, "World Beef Trade Patterns," Foreign Agriculture, XI, No. 26 (Washington, D. C.: Government Printing Office, 1973).

b/ Estimated.

c/ Figures for 1972-1973 are obtained from Bruce L. Greenshields, "U. S. Agricultural Sales to Japan Headed for \$2 Billion Mark," Foreign Agriculture, XI, No. 26 (Washington, D. C.: Government Printing Office, 1973). Figures for 1971 were obtained from R. S. Lowen, "Japan's Beef Imports Up--Short Term Outlook Clouded," Foreign Agriculture, XII, No. 10 (Washington, D. C.: Government Printing Office, 1974).

Despite increases in domestic production for some of the above mentioned importing countries, it appears their domestic demand is expanding at a rate which is tending to have noticeable impact on all meat product price equilibriums. This phenomena is reflected in increasing beef prices over time for the entire world market.

In New York, frozen manufactured beef prices increased from an average of 67.1 cents a pound in 1972 to 84 cents a pound during the first quarter of 1973. Argentina cuts, which sold in London at an average price of 90.9 cents in 1972, increased to \$1.09 during the first quarter of 1973. 4/ In Tokyo markets in March of 1973, beef loin sold at \$11.90 a pound, T-bone steak at \$3.57 a pound, and ground beef ranged from \$1.70 to \$3.40 a pound. 5/ These prices expressed in U. S. dollars cannot be interpreted without knowledge of the magnitude of the general level of wages, prices, and exchange rates. However, even without data support, we could conclude that beef prices are among the highest in the general food group in Japan.

There are indications that pressures by consumers in the major importing countries are becoming sufficiently strong to force their respective government's importing policy toward lower duties and the

4/ Ibid.

5/ U. S. Department of Agriculture, Foreign Agricultural Service, Foreign Agriculture, XI, No. 14 (Washington, D. C.: Government Printing Office, 1973), p. 5.

relaxation of other trade barriers to achieve lower domestic beef market prices. Coupled with this relaxing of import restrictions many governments of exporting countries have instituted various export taxes and export controls in an attempt to capture larger shares of the trade revenue. Nevertheless, as a result of increased import demand, world trade volume in fresh, chilled, and frozen beef rose sharply to a new record of 2.2 million tons for 1972 which is 16 per cent more than that recorded in 1971.

Table I also suggests that production in these major importing countries has increased at a lower rate than consumption. This condition emphasizes the need for increased annual imports. The growth in consumption of meat products is predominantly caused by increased population and increased per capita consumption. It is a generally accepted hypothesis that the income elasticity for meat products is large and positive. The growing gap between domestic production and consumption in the importing country has produced an upward moving world price for meat in recent years. (See Table II.) The pressure of increasing meat prices has a significant impact on foreign trade policies of these importing countries. The consumer pressures usually relate to suspension of trade barriers in the form of lower duties or levies or increased import quotas.

The European Economic Community levies have not been in operation since January, 1972. Import duties were temporarily reduced in June,

TABLE II. PERCENTAGE INCREASE IN AVERAGE CATTLE PRICES IN SELECTED COUNTRIES FOR 1971-1972 AND FIRST QUARTER OF 1972-1973.*

Country	Average Annual Increase 1971-1972 a/	Increase for 1st Qtr. 1972 to 1st Qtr. 1973 a/
	Pct.	Pct.
Canada	9	20
United States	10	28
EC-6	22	15
United Kingdom	18	39
Australia	10	15
Argentina	64	81

a/ It was measured in domestic currency, but it was not clear from the text whether it was deflated or not.

*Source: Food and Agriculture Organization, Committee on Commodity Problems, Review of the World Meat Situation and Outlook (Rome, Italy: June, 1973).

1972 by one-half for slaughter beef cattle and completely suspended for the importation of young animals for fattening. Similarly, non-preferential tariffs were suspended in the United Kingdom in June, 1972 and this suspension will continue after it joins the European Economic Community. Also during the same period, the United States lifted restrictions on beef imports, as covered by the meat import law, and the beef import quota in Japan has been increased substantially.

The increased world import demand coupled with growing domestic requirements also has caused a progressively worsening beef situation in domestic markets of exporting countries. This leads to a situation where the domestic market was balanced at a higher equilibrium price. 6/ On the other hand, in some exporting countries exports had to be discouraged due to the pressures exercised by domestic consumers. Brazil has lowered its export target significantly in order to bring stability to the home market, while the Dominican Republic put a ban on meat exports effective April, 1973. East European exporters attempted to resolve the problem by imposing export quotas. For example, Yugoslavia introduced an export quota covering both calves and fat cattle as from March, 1973.

The outlook for the near future indicates that world demand for beef is likely to remain strong. The expected limited size of the

6/ Australia and Argentina are among these countries. (See Table II.)

production increases in beef as well as the possibility of continuing rise of input costs will mitigate against substantial reductions in world meat supply prices. However, regional price fluctuations are, of course, not ruled out.

CHAPTER II

THE PROBLEM

Area of Study

The geographic area of this study is limited to the country of Japan but excluding the Okinawa Islands. The exclusion of Okinawa is forced by unavailability of data since the Government of Japan has only recently gained control of the islands.

Japan is the only country in Asia whose economic growth has produced a per capita income comparable to developed nations of the West. Japan has a population of approximately 103 million in 1970 and operates under a free market economy to a certain degree. Although growing prosperity and higher income levels are undoubtedly the major causes of expanded per capita beef consumption in Japan, other variables are also producing significant effects on changes in consumption patterns. Beef prices are clearly one of the strongest factors in determining variations in consumption levels. In addition to price and income, non-economic factors such as tradition, eating habits, and locational influences help to shape consumption patterns.

Per capita beef consumption estimates indicate that the Japanese people consume very little beef. Information relative to the Japanese demand for beef will assist future research efforts in examining influences from economic factors such as income, population, and prices against non-economic factors of an Oriental cultural environment. Hopefully, results of this inquiry could be used or applied

with some modification to other Asian countries having a comparable setting.

Economic Growth and Change

The rate of economic growth in Japan during the period of this study (1953-1970) was indicated by a 15 per cent average annual increase in national income. Japan's rate of population growth during this period was relatively low averaging about 1.1 per cent annually. The recorded average annual increase in prices during the same period was about 5 per cent with a real per capita income rate of growth at approximately 9 per cent per year. These estimates are illustrated in Appendix Table VI and Figure 1.

In 1971, Japan experienced some slow down in economic growth recording a 6.1 per cent real growth rate, but it started to recover at the beginning of 1972 and continued throughout the year resulting in an overall 9 per cent real growth rate. In 1972, per capita GNP reached \$2,762 in current prices which would equal \$2,004 in constant 1965 prices. 1/

A substantial portion of Japan's growth process can be explained by the industrial sector which is one of the best and most efficient

1/ U. S. Department of Agriculture, Foreign Agricultural Service, Agricultural Attache Report No. JP3004 (Tokyo, Japan: January 26, 1973), p. 1.

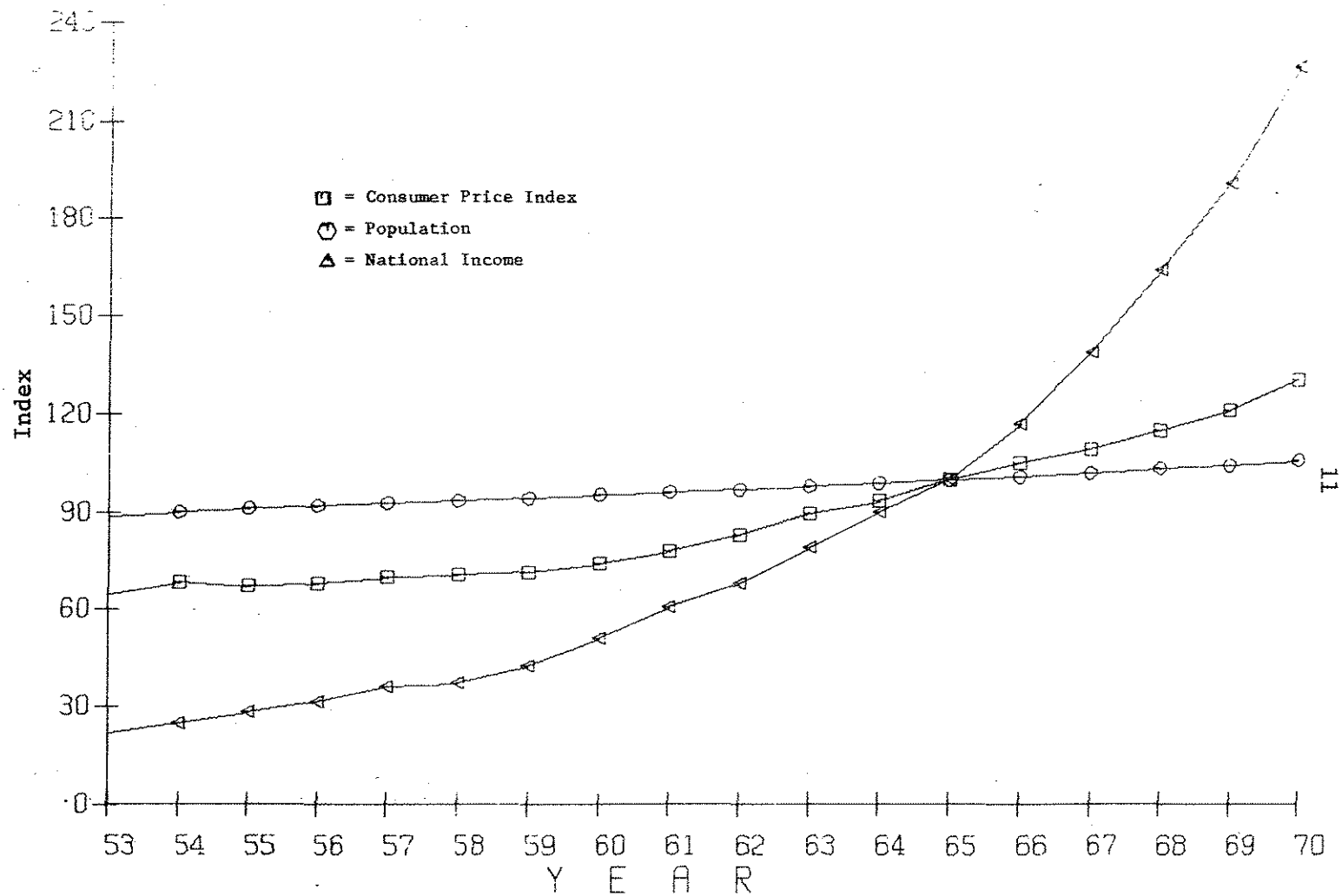


Figure 1. Japan: Growth of Population, Income and Consumer Prices (1965 = 100).*

*Source: Computed from Appendix Table

ones in the world. Industrialization implies technological change will occur and it also induces social change. Kaneda indicates that changes in Japan were caused by:

- 1) urbanization;
- 2) massive exposure of the Japanese people to the influences of foreign cultures; and
- 3) the rapid acculturation of those influences through mass communications. 2/

These socio-cultural and technological changes have had a profound impact on the Japanese life style including their food consumption patterns.

Growing Demand and Constrained Supply

Rising per capita incomes, urbanization, and modernization of the industrialized economy has led to increases in the consumption of preferred and expensive foods, as well as increases in per capita calorie intake. While rice is still considered the main staple food accounting in 1972 for 49 per cent of the calorie intake, fish is still widely consumed; however, consumption has been shifting toward such foods as fruits, vegetables, and livestock. These observations are in accord with the experiences of many Western countries, i.e., consumption

2/ H. Kaneda, "Long Term Changes in Food Consumption Patterns in Japan," Agriculture and Economic Growth: Japan's Experience, ed. by Ohkawa and B. Johnston (Tokyo: The University of Tokyo Press, 1969).

in these countries have also shifted toward more expensive foods and away from high carbohydrate foods. Total per capita calorie intake for Japan was 2,300 for 1960, 2,437 for 1966, and 2,471 for 1970. From these estimates the proportion accounted for by cereals was 61 per cent, 56 per cent, and 50 per cent, respectively. 3/

The consumption of rice remains relatively high despite the decline in the proportion of cereals in the total calorie intake. The generally accepted reason for this is that there has been an increase in total calorie intake and this increase has been primarily in animal foods. Consumption of animal foods is still relatively small. Average daily intake of animal protein (in grams) was 7.6 for the years 1934-1938, 14.3 for 1955, 18.8 for 1964, and 27.8 for 1970. Of the protein consumed at these four points in time, 5.4g, 10.2g, 11.3g, and 16.0g were derived from fish and only 0.5g, 0.6g, 1.0g, and 1.0g were derived from beef. 4/

According to Yuize, Japanese tradition has acted as an inhibiting factor to the expansion of animal protein consumption except of marine origin. 5/ But tradition has become less decisive in modern urban

3/ Computed from "Food Balance Sheet" contained in Statistical Year-book of the Ministry of Agriculture and Forestry, Government of Japan, Tokyo, relevant issues.

4/ Ibid.

5/ Yasuhiko Yuize, "The Demand for Meat, Milk and Eggs in Postwar Japan," Rural Economic Problems, III, No. 1 (Tokyo, Japan: The International Association for Agricultural Economics in Japan, 1966).

areas of Japan where the higher income classes are concentrated. It may be safe to conclude that animal food, in general, and beef consumption, in particular, will continue to expand as long as economic growth continues.

In a static equilibrium framework the quantity demanded and quantity supplied of beef products will be equated since the quantities marketed and purchased are adjusted through price. Food demand in general reflects consumers' purchasing power. The dynamics of the market has indicated that Japanese beef demand has consistently shifted to higher levels relative to beef supplies since 1960 which has resulted in rising beef prices.

Economic growth in commerce and industry was responsible for generating most of the increased consumer purchasing power. Income and output from the agricultural sector has lagged behind the rest of the economy. The apparent inability of agriculture to adjust and expand output to match this growth process is highly associated with the land constraint.

Land devoted to agriculture also declined through time. In 1956, total area planted was recorded at 8.2 million hectares while in 1965 it declined to 7.3 million hectares, a reduction of about 10 per cent. ^{6/} Except for 1960 this trend has continued each year recording

^{6/} Japan, Bureau of Statistics, Office of the Prime Minister, Abstract of Statistics on Agriculture (Tokyo: 1960 and 1969).

6.000 million hectares for 1971. It is anticipated that in the future even more land may go out of agricultural production.

The agricultural labor force (including part-time workers) has declined steadily from 19.5 million persons in 1955 to 15.2 million persons in 1965. The figure for 1970 is 10.2 million. Since the number estimated to be part-time and seasonal workers remained roughly stable at about 5 million, most of the decline must have occurred in farm managers and full-time workers. ^{7/} Consequently, it seems a reasonable hypothesis that some withdrawals of land from agricultural production was accompanied by labor withdrawals. Support for the aforementioned hypothesis was also drawn from Shinohara ^{8/} who mentioned that larger farms are increasing in number clearing the way for adopting technological changes and mechanization. He calculated that between 1950 and 1960 farms of 2 to 3 hectares, 3 to 5 hectares, and 5 hectares and over, had increased in number by about 12 per cent, 18 per cent, and 25 per cent, respectively.

With respect to livestock production, the traditional Japanese production pattern was to raise dairy cattle as the primary activity

^{7/} Ibid.

^{8/} T. Shinohara, "Japanese Import Requirements: Projections of Agricultural Supply and Demand for 1965, 1970, and 1974," (Department of Agricultural Economics, University of Tokyo, 1964).

and view the beef cattle enterprise as a complementary activity. The adaptation of new technology toward more efficient beef cattle operations has been very slow due in part to the lack of capital investment.

In addition to the above mentioned production problems, the food supply, in general, and beef supply, in particular, have been constrained by restrictive import policies. The Japanese Government is certainly aware that to circumvent the beef price and supply problem it could place constraints on demand or expand supply. However, restriction on demand would most likely imply a reduction of consumer's purchasing power. This could and probably would produce adverse side effects such as dampening or stagnating economic growth. Consequently, the most reasonable policy toward food price stability and a better diet lies through measures related to expanding supply. In the absence of means to relax domestic production constraints in the near future, an apparent policy would suggest that the Japanese Government adopt a gradual relaxation on import constraints. This dependence on imports for expanding supply appears to be the case as suggested by the data presented in Table III.

Agricultural and Trade Policies

The agricultural sector in the Japanese economy was apparently heavily affected by the industrialized economic growth. A land reform bill was enacted after World War II. The intent was to broaden the ownership base of agriculture land and associated production while at

TABLE III. RATIO OF SUPPLY FROM DOMESTIC SOURCES TO TOTAL AVAILABLE
SUPPLY OF MEAT PRODUCTS, JAPAN.*

Japanese Fiscal Year a/	Beef	Pork	Chicken
1953	1.000	1.000	1.000
1954	.989	1.000	1.000
1955	.993	1.000	1.000
1956	.964	1.000	1.000
1957	.836	1.000	1.000
1958	.978	1.000	1.000
1959	.980	.994	1.000
1960	.959	.962	1.000
1961	.959	.996	1.000
1962	.975	1.000	1.000
1963	.975	.972	.966
1964	.979	.994	.978
1965	.945	1.000	.962
1966	.916	1.000	.978
1967	.902	.960	.968
1968	.920	.950	.949
1969	.930	.936	.955
1970	.890	.976	.977

a/ Ending March 31.

*Source: Calculated from data given in Appendix Tables I, II, and III.

the same time limiting the size of commercial farms. This bill might be supported from the viewpoint of income distribution but it appears that it may have produced adverse effects in terms of productivity. Farms simply are too small to gain economies associated with larger production units and soon it becomes apparent that the agricultural sector was lagging behind the efficient expansions of the rest of the economy. In addition there is the problem of the limited physical land base which has large economic value for uses other than agricultural. In attempts to alter the disparity between productivity in agriculture and that in other sectors of the economy, the Japanese Government has initiated several policy measures and/or revoked earlier established ones which were considered to place agriculture at a disadvantage in the competition for resource use.

The Agricultural Land Act of 1952 was initiated to encourage the enlargement of the units which in turn leads to more specialization and attainment of possible economies of size. The Agricultural Basic Law and the Livestock Price Stabilization Act, both passed during 1961, were intended to encourage the production of high income commodities for which the demand was increasing. More current policies of the Japanese Government (toward price related to commodities such as soybeans and wheat) are aimed at the dual purpose of selective expansion of agricultural production with consistent consideration for changing demands as well as increased producers income.

The livestock production industry has the potential to benefit the most from Japan's growing affluence. It is one of the best protected industries in Japan. Tight import restrictions have been placed on beef, pork, and chicken. During 1967 imported beef comprised only 2.1 per cent of total available supply; pork 0.6 per cent; and chicken 2.2 per cent. Table III indicates the relatively minor importance of foreign trade in the economic adjustment related to supply of these commodities due to protective policies adopted by the Japanese Government. It also emphasizes that in recent years the Japanese economy has relied more heavily on imports of meat products.

Most of the goods imported into Japan require licenses. Essentially, the license system was designed for controlling prices and to improve the balance of payment problems. Three types of controls were initiated which vary in the degree of control over import licenses. The three types listed below are in the order of the increasing difficulty with which licenses are obtained.

1) Automatic Approval.--This import license is the least restrictive. The licenses are issued automatically to importers at any foreign exchange bank. This system is flexible since it can be tightened by deleting some commodities from the list or liberalized by adding to it.

2) Automatic Import Quota.--This type of structure was established as a transition step. It is slightly more restrictive than

the above system. It requires applications be made to the Ministry of International Trade and Industry before licenses are granted.

3) Funds Import Quota.--This is the most restrictive grouping. Funds programmed under this category become a ceiling above which imports are not likely to be permitted. In addition to the above groupings there are certain commodities which fall under the state trading regime (rice and tobacco).

In terms of tariffs, Japan has a two-column tariff schedule. One column sets forth rates bound under the General Agreement on Tariff and Trade, while the other sets general rates aimed at relaxing the restrictive impact of tariffs to preferred countries. Duties on processed agricultural goods are relatively high (25 to 35 per cent).

Over time, Japan's foreign trade policies have undergone noticeable changes as a result of its economic growth. The movement in policy has been toward the endorsement of a free trade concept. Trade liberalization has been initiated generally by moving commodities and import quota to either the Automatic Import Quota or the Automatic Approval class. However, relaxation of the non-tariff trade barriers have been somewhat offset by the implementation of an upward adjustment in tariff rates. The notion being to offset impact of increased imports on domestic prices and their impact on producer prices. Progress in trade liberalization for farm products has been relatively slow. Around 1969, Japanese consumers appeared to have applied sufficient

pressure to bring about a degree of relaxation in quantitative import restrictions and to have some impact on tariffs. The number of commodities under quota were reduced from 120 to 34 with about half of these items being agriculture related. (See Table IV.) On the tariff side in 1971, a variable levy-type system was installed. These selective restrictions were adjustable in accordance with policy related to domestic production goals and prices.

Under the Generalized System of Preferences, a procedure which took effect on August 1, 1971, Japan extended to most of the less-developed countries certain tariff reductions which amounted to anywhere from 20 to 100 per cent of the applicable most favored nation tariff rate. These were applicable on 59 agricultural and fishery products.

Specifically, beef imports are still restricted by the quota system and a 25 per cent ad valorem tariff. For beef imports purchased other than by the Livestock Industry Promotion Corporation (LIPC), an additional variable levy is imposed. The LIPC is a semi-governmental agency which now exerts significant control over beef imports.

In 1967 the LIPC was allocated 6,000 tons of a total beef quota of 19,000 tons and 16 authorized private importers were allocated the rest. The LIPC control over beef imports has increased since then. Of the 1972-73 quota of 71,500 tons, only 14,000 tons were allocated to the 23 approved importers in the private sector while the rest were allocated to the LIPC.

TABLE IV. JAPAN'S QUANTITATIVE RESTRICTIONS ON AGRICULTURAL PRODUCTS BY ITEM, 1968-1972.*

Items Liberalized Since 1968				Items Still Under Restriction
April 1970	Sept. 1970	Jan. 1971	June 1971	
Dried Dates	Lemon Juice	Fresh Grapes	Fresh Grapefruit ^a	:Beef
Fruit Flavors	Margarine	Cake Mixes	Soybean Oil Cake	:Certain prepared meat items
Instant Coffee	Shortening	Macaroni	Rapeseed	:Processed cheese
Fruit Flour	Manioc	Corn Flakes	Vegetable Oil ^a	:Dried peas
Gluten	Potato Flour		Peanuts	:Other pulses (navy, pinto,
Malt Sugar	Tapioca		Sausage	: great northern, lima)
			Live Horse ^a	:Oranges
Oct. 1971	April 1972		Bases for Non-	:Tangerines
Live Cattle ^a	Ham and Bacon ^a		alcoholic	:Wheat, rice, barley flour
Live Swine ^a	Salted Meat		beverages ^b	:Peanuts, other than for oil
Pork ^a	Refined Beet & Cane		Fresh apples ^b	: extraction
Instant Potatoes	Sugar ^a		Frozen Pineapple	:Dates, denatured
Canned Corn	Tomato Puree & Paste		Dark Black Tea	:Grapes, malted milk sugar
Confectionary	Certain Mixed Feeds ^a		Non-feed Grain	:Sugar syrup, caramel,
Cookies	Rocky Candy		sorghum	: artificial honey
Molasses			Lemonade & Spa	:Fruit puree, pastes, pulps
Nectar			water	:Canned pineapples
Peppermint Oil				:Roasted peanuts
				:Fruit juices
				:Tomato juices, tomato
				: ketchup and sauce
				:Mixed seasonings
				:Ice Cream powder
				:Prepared infant milk powder
				:Food preparations based
				: on wheat or rice
				:Malt

^a Tariff rates increased when quotas removed. ^b Imports still restricted for sanitary reasons.

*Source: U. S. Department of Agriculture, Foreign Agricultural Service, Agricultural Trade Policy (Washington, D. C.: Government Printing Office, June, 1972).

Beef quotas are set by the Japanese Ministry of Agriculture and Forestry in consultation with the Japanese Meat Council. The Ministry of Agriculture and Forestry also has the prerogative to suspend beef imports through the quota allotted to the LIPC. Quotas are generally issued twice in Japan's fiscal year.

Once issued, however, quotas may be used for a period of 10 months or longer if the shipment is delayed. Thus, actual imports can vary from quota levels, although the quotas provide a rough estimate of future imports. But the nature of Japan's meat imports is undergoing substantial change.

Quota relaxation on beef imports has been associated with increased flows which have reached an average increase of 38 per cent during the 1970-73 period. Pork, live swine, and live cattle quotas were eliminated in 1971. Poultry, fresh, chilled, or frozen, is subject only to health and sanitary regulations. Other meats, except for beef, are subject to the variable levy tariff structure.

Research Problem and Hypotheses

The fact that world demand for beef has increased at a faster rate than the world supply, which is reflected through increasing world equilibrium prices, tends to support the notion that there is currently a growing "world beef shortage." This condition developed at a time when several major importing countries were still employing trade barriers as a means of keeping domestic prices at a higher level.

Import tax levies and quotas were imposed on beef imports which distorted market flows.

The economic effects of these trade restrictive policies were to increase the price received by domestic producers of beef products with lower total domestic consumption than would result under free trade. In the case of Japan, the barriers are in terms of a 25 per cent import levy coupled with periodically established quota restrictions. Given the level of income observed in Japan (U. S. dollar equivalent 2004 in 1972 at 1965 prices), it is expected that these severe trade restrictive policies are a major cause of the observed high prices. Comparison of Japan with other countries of similar income levels would likely lead to the conclusion that Japanese beef consumption under free market prices would increase. The major problems to be researched are what one might expect the Japanese to consume as a result of more intensified relaxation of the beef import quota system and what this consumption would mean to world trade equilibrium prices. The Japanese annual per capita beef consumption in 1971 was 7 pounds. Because Japan's beef consumption per capita is now the lowest of any comparably developed country, it has a potential for a wide range of choice in determining its future consumption levels. This power to choose is a result of the ability of the Japanese Government to allocate production resources in alternative patterns.

For the last three years there existed some indication that due to pressure of domestic demand for beef the Japanese Government has moved towards the relaxation of trade barriers by decreasing levies and increasing annual import quotas. It is expected that this movement will continue. The above observed facts lead to the major question posed for this study.

Given the policy adopted by the Japanese Government to increase import quotas substantially as a result of consumer's pressure how will it affect the prevailing market price and what, if any, impact will this change have on world equilibrium prices? The aforementioned problem statement could be casted in more detail in the form of the following hypothesis:

- 1) The observed low per capita beef consumption in Japan at present is mainly induced by constrained supplies and high price levels which reduce the full effect of increased income.
- 2) Moderate increases in quantity of beef supplied originating from imports and domestic production will not appreciably affect the prevailing high beef prices.
- 3) The expected change in quantity of beef consumed in Japan as a result of increased imports will have an important and observable influence on world equilibrium prices and modify the trade flow pattern of exporting countries.

These hypotheses depend a great deal on consumer behavior. Traditional Western conclusions about consumer behavior may not be transferable to the Japanese society in terms of quantity magnitudes. The experience of Western countries may not be a reliable guide to the future of Japan--the first Eastern country to reach Western levels of economic development. Thus, the true test of the hypotheses may require a time factor beyond the scope of this research effort but this will not exclude drawing conclusions with an adequate set of assumptions.

At this time there is insufficient reliable economic information on the demand for beef or meat products in Japan to enable one to make reasonable projections of equilibrium supply and demand relationships. Consequently, this study is concerned with estimating such information from which sound and refined analyses can be made with respect to the structural relationship of demand for beef. Additionally this study will examine the economic implications of alternative policy action in relation to other economic variables in Japan as well as the world market level.

A strong Japanese demand for beef can be expected to modify the world feed grain trade pattern. In view of the decisive role played by Japan in international economics, changes in her trade patterns could imply a much larger outflow of feed grain from surrounding countries in Southeast Asia. These demand changes could be expected

to compete with human consumption of these grain products. It is hoped that the results of this inquiry will carry informational value for the beef industry in both importing and exporting countries as well as the feed grain producing countries of Southeast Asia. To define the feed grain demand function implies knowledge about the marginal value product of feed grains for livestock and this in turn requires estimates of the livestock prices that can be expected under various trade policies. This type of information is fundamental to meaningful economic analyses for importing and exporting nations as well as those interested in the competition for alternative protein sources and use.

Scope and Objectives of the Study

In view of the above mentioned research problem and related hypotheses, there are four major objectives of this study. The first is to estimate the parameters of the demand function for Japan. Supply forces will be taken into account as long as they are assumed to have significant effects on price but the primary purpose is to obtain the best estimates on the demand side. The second is to determine the direct and cross price elasticities, income elasticities, and if possible, marginal impact coefficients of other relevant variables with respect to demand for beef in Japan. The third is to project the equilibrium price--quantity points for changes in trade policies which Japan might be expected to initiate. The fourth is to relate changes

in Japanese trade policy for beef to the impact it might carry on world equilibrium conditions of supply and demand for beef.

Previous Studies

Very little published research of econometric nature relative to the Japanese demand function for beef is available in the English language. Most of the existing empirical work has been concentrated on long-run projections of demand and has treated lightly (when at all) the production or impediment to supply in terms of import quotas. A Food and Agriculture Organization study covered Japanese demands for various foods as part of a worldwide projection study. In that study, trade barriers were assumed absent and demand was considered as a function of income which then was used to project world demand for agricultural commodities to 1980. 9/

Shinohara studied the demand for livestock products to the extent that it enabled him to compute projected long run outlook import requirements of dairy products and feed grains. 10/

The most technical investigations available to date have been done by Yuize. 11/ He concentrated his market analyses upon the demand for

9/ Food and Agriculture Organization, Commodity Projections.

10/ Shinohara, "Japanese Import Requirements."

11/ Yuize, "The Demand for Meat, Milk and Eggs."

meat, milk, and eggs with a combined cross-section and time series data covering 1957-1962. His primary purpose was to estimate the quantitative effects of family size, regionality, substitution, custom and expectation on demand.

Another demand study was performed by Kaneda with the objective to identify long-term changes in food consumption patterns as a direct function of income. ^{12/} Filipello investigated the dynamic aspects through an econometric investigation of the Japanese grain-livestock economy. ^{13/} The demand for beef and the supply of beef were estimated simultaneously within a framework of the Japanese grain-livestock system. In addition to wide coverage of the subject of the structural specification and market characteristics of the system, he also concentrated his analysis on the estimation techniques themselves. He did consider import policies to the extent of setting them up as a function of quantity domestically produced and domestic prices.

The general conclusions derived from the studies, as they relate to the present investigation, include:

- 1) Income elasticity of demand estimates for beef ranging from .75 to 1.046.

^{12/} Kaneda, "Changes in Food Consumption."

^{13/} A. Filipello, "A Dynamic Econometric Investigation of the Japanese Livestock Economy" (unpublished Ph.D. dissertation, University of Missouri, 1968).

- 2) The increase in meat consumption has caused no great damage in the traditional diet with meat being substituted mainly for fish and only to a small extent for rice and other non-animal foods.
- 3) The domestic beef production industry is still relatively undeveloped.
- 4) As the industrialization process continues, changes in Japanese food consumption habits will occur. However, no clear picture emerges which can be used to project the new equilibrium quantities or prices which might be expected with respect to meat products.

In addition to the above mentioned studies the Japanese Ministry of Agriculture and Forestry studied the basic aspects underlying the determination of livestock products production and demand. This study was basically a non-statistical analysis with projections based upon recent facts and expectations of the future. 14/ All the above studies are valuable to the approach and effort that will be used in the present investigation. These results are extremely valuable as guidelines, input information, or as a framework for comparative results whenever it is appropriate.

14/ Japan, Ministry of Agriculture and Forestry, "Long Range Outlook for Demand, Supply and Production of Agricultural Commodities in Japan" (Tokyo: November, 1966).

CHAPTER III

THE THEORETICAL FRAMEWORK

A Review of the Theory of Consumer Demand

The usual textbook derivation of demand functions starts with assumptions relative to consumer's behavior. The usual starting point in this process is the assumption of rationality of consumers. The postulate of rationality can be stated as: (a) for all possible pairs of goods A and B the consumer knows whether he prefers A to B or B to A, or whether he is indifferent between them; (b) only one of the three possibilities is true for any pair of goods; and (c) preferences are transitive. ^{1/} It is also assumed that all information pertaining to the satisfaction that the consumer derives from various quantities of commodities can be formulated into a utility function. Further, it is assumed an individual consumer confronted with given commodity prices and personal income acts so as to maximize utility. Following Pareto this function does not require cardinal utility interpretation but is an ordinal utility measure which merely provides a consistent ranking of commodity preferences.

Utility Maximization

Mathematically a consumer's utility function is not unique but is assumed to be an increasing function with continuous first- and

^{1/} J. M. Henderson and R. E. Quandt, Microeconomic Theory (2nd ed., New York: McGraw-Hill Book Company, Inc., 1971).

second-order partial derivatives. This type of function is (as expressed in (1) below) assumed for all the following statements.

Starting with an ordinal utility function,

$$U = U(x_1, x_2, \dots, x_n) \quad (1)$$

subject to

$$\sum_{i=1}^N p_i x_i = I \quad (2)$$

where $(p_1, p_2, \dots, p_n, I)$ are each pre-assigned parameters for prices and income, and $(x_1, x_2, \dots, x_n)$ are the quantities of individual commodities consumed. In this case, one is concerned with a single consumer buying commodities in a market in which he cannot appreciably affect prices regardless of how much is purchased.

The maximization of a function subject to a constraint or set of constraints can be found by the well-known method of Lagrangian multipliers. Consider the following Lagrangian multiplier expression formed from equations (1) and (2):

$$F = U(x_1, x_2, \dots, x_n) + \lambda(I - \sum p_i x_i) \quad (3)$$

where λ is a non-zero variable whose meaning will be explained later.

To solve for a maximum one first takes the partial derivative of F with respect to the $n+1$ variables $(x_1, x_2, \dots, x_n, \lambda)$ and sets them equal to zero. The solution of this system of equations is the first-

order (necessary) conditions for a maximum and can be expressed as:

$$\begin{aligned}\frac{\partial F}{\partial x_i} &= U_i - \lambda p_i = 0 & (i = 1, \dots, n) \\ \frac{\partial F}{\partial \lambda} &= I - \sum p_i x_i = 0.\end{aligned}\tag{4}$$

The last equation assures that the constraints (in this case income of the consumer) in (3) is satisfied. The second-order (sufficient) conditions for utility of the consumer to be a maximum must be met. The usual method of determining if a true maximum is reached is to use bordered Hessian determinants. ^{2/}

Given that the necessary and sufficient conditions are satisfied, the $n+1$ equations in (4) are then solved for a set of demand functions

$$x_i = f_i(p_1, p_2, \dots, p_n, I)\tag{5}$$

and a functional relationship for λ ,

$$\lambda = h(p_1, p_2, \dots, p_n, I).\tag{6}$$

Demand functions represented by equation (5) show that the quantity demanded for any particular commodity is a function of its price, the prices of other commodities, and income. It can be shown that these demand functions are homogeneous of degree zero in prices and income.

^{2/} For procedure and justification, see Henderson and Quandt, Micro-economic Theory.

The solution to the equation set in (4) can also be expressed as

$$\frac{u_1}{p_1} = \frac{u_2}{p_2} = \dots = \frac{u_n}{p_n} = \lambda \quad (7)$$

where

$$u_k = \frac{\partial u(x_1, x_2, \dots, x_n)}{\partial x_k}.$$

Equation (7) states that for total utility to be at a maximum, marginal utility divided by price must be the same for all commodities. It also implies that in equilibrium the marginal utility of the last dollar spent for each and all commodities must be identical. The Lagrangian multiplier λ also has an interpretation. It has been termed the marginal utility of income. ^{3/} This can be noted simply by differentiation of equation (3) with respect to I , i.e.,

$$\frac{\partial F}{\partial I} = \lambda = \text{marginal utility of income} \quad (8)$$

which in words simply says the change in utility per unit change in income is equal to λ .

In addition to ruling out satiation points of utility functions, the assumption that U is a non-decreasing function in the relevant range guarantees that $\partial U(x_1, x_2, \dots, x_n) / \partial x_k \neq 0$ which is a necessary

^{3/} P. A. Samuelson, Foundations of Economic Analysis (Cambridge, Mass.: Harvard University Press, 1971).

condition for the n equations in (5) to be defined. The demand functions derived in this fashion are contingent upon satisfying the first- and second-order equilibrium conditions.

Demand Functions

Unless otherwise stated, demand functions denote quantity demanded for any particular commodity as a function of prices and income. In modern economic literature demand functions defined in this fashion usually are recognized as ordinary or Marshallian demand functions.

It is to be recognized that there are several interpretations of the Marshallian demand function. Milton Friedman points out that to preserve internal consistency in economic theory it is necessary to interpret the Marshallian demand function in a sense that real income or money income is constant. ^{4/} This interpretation gives rise to the well-known compensated demand curve.

There are two versions of this demand curve. One is that obtained by compensating consumers' income and the other is obtained by compensating the prices of other commodities. Both of these are mathematically equal and it can be shown that, in the limit, both of them will be identical with keeping the individual on the same utility level.

^{4/} Friedman demonstrates that the constant money income interpretation will result in a demand curve that will shift with every change in price of one commodity, viewed from the resource allocation and supply side. Milton Friedman, The Marshallian Demand Curve, in Essays in Positive Economics (Chicago: The University of Chicago Press, 1970), pp. 47-99.

Two important properties of demand functions can now be deduced. 5/

The first property is that the demand for any commodity is a single-valued function of prices and income. The basis of this property is the Implicit Function Theorem that if for a given set of values of the parameters $(p_1^0, p_2^0, \dots, p_n^0, I^0)$ and a set of values for the unknowns $(x_1^0, \dots, x_n^0, \lambda^0)$ satisfy equation (4) and if the matrix $[U_{ij}]$ is of rank N in a neighborhood of (x^0, p^0, λ^0) , then equations (5) and (6) represent a single-valued, continuously differentiable function in a sufficiently small neighborhood of $(x_1^0, \dots, x_n^0, \lambda^0, p_1^0, \dots, p_n^0)$. 6/

In addition, if the bordered Hessian determinant satisfies the second-order conditions mentioned earlier, then it implies that the matrix is quadratic and negative definite under the specified constraints. This establishes the convexity property of indifference curves.

The second property of demand functions is that they are homogeneous of degree zero with respect to prices and income. Consider maximization of the following utility function:

$$U = g(x_1, x_2, \dots, x_n) \quad (9)$$

subject to

5/ Henderson and Quandt, Microeconomic Theory.

6/ Samuelson, Foundations of Economic Analysis.

$$k \sum p_i x_i = kI \quad (10)$$

where k is the factor of proportionality. The Lagrangian expression (3) now becomes

$$H = g(x_1, x_2, \dots, x_n + \lambda k(I - \sum p_i x_i) \quad (i = 1, \dots, n). \quad (11)$$

The first-order conditions are then

$$\begin{aligned} \frac{\partial H}{\partial x_i} &= U_i - k\lambda p_i = 0 \\ \frac{\partial H}{\partial \lambda} &= k(I - \sum p_i x_i) = 0 \quad (i = 1, \dots, n). \end{aligned} \quad (12)$$

Now, since $k \neq 0$ it follows that the last equation in (12) can be written as

$$I - \sum p_i x_i = 0. \quad (13)$$

With respect to the other n equations in (12) one can eliminate k from all of them by moving the second term to the right and performing pairwise division. This results in

$$\frac{u_1}{p_1} = \frac{u_2}{p_2} = \dots = \frac{u_n}{p_n} = \lambda \quad (14)$$

which is the same as equation (7). Therefore, the demand function derived from the price-income set $(kp_1, kp_2, \dots, kp_n, kI)$ yields the same equilibrium set as for the price-income set $(p_1, p_2, \dots, p_n, I)$.

It can also be shown that the second-order conditions are unaffected. This satisfies the conditions necessary to show that the demand functions are homogeneous of degree zero in prices and income. It implies a relevant and empirically testable restriction upon consumer's behavior, a prediction of absence of a money illusion. 7/ For $k > 0$,

$$x_i = k f_i(p_1, \dots, p_n, I) = f(kp_1, \dots, kp_n, kI). \quad (15)$$

Demand functions theoretically satisfy a number of important relationships. Two of these properties cited from P. S. George and G. A. King are considered relevant to the process of this study. 8/ These properties follow from differentiation of the first-order conditions of constrained utility maximization.

Homogeneity Conditions

By Euler's Theorem for homogeneous functions of degree zero,

$$p_1 \frac{\partial x_1}{\partial p_1} = p_2 \frac{\partial x_1}{\partial p_2} + \dots + p_n \frac{\partial x_1}{\partial p_n} + y \frac{\partial x_1}{\partial y} = 0. \quad (16)$$

By dividing through (16) by x_i one obtains the elasticity for commodity i , all cross elasticities, and income elasticity as indicated by E_{ij} 's below.

7/ Henderson and Quandt, Microeconomic Theory.

8/ P. S. George and G. A. King, "Consumer Demand for Food Commodities in the United States with Projections for 1980," Giannini Foundation Monograph No. 26 (Berkeley, Calif.: California Agricultural Experiment Station, March, 1971).

$$E_{i1} + E_{i2} + \dots + E_{in} + E_{iI} = 0$$

or

$$E_{i1} + E_{i2} + \dots + E_{in} = -E_{iI}. \quad (17)$$

Equation (17) states that the sum of the direct and cross elasticity of demand of a particular commodity is equal in absolute value to the income elasticity of demand for that commodity. Homogeneity properties of these functions result from the assumed properties of the utility function described in equations (9) through (15).

Slutsky or Symmetry Conditions

The effects of interrelated changes in prices and income on quantity can be obtained by taking the total derivative of equation (4). A change in quantity consumed of the i -th commodity as a result of a change in the price of the j -th commodity can be represented as

$$\frac{\partial x_i}{\partial p_j} = \left(\frac{\partial x_i}{\partial p_j} \right)_{u \text{ const}} - x_j \left(\frac{\partial x_i}{\partial y} \right)_{p \text{ const}} = k_{ij} - x_j \frac{\partial x_i}{\partial y}. \quad (18)$$

The first term on the right-hand side of equation (18) was identified by Slutsky as the residual variability of the j -th commodity for a compensated change ($du = 0$) in the i -th price. ^{9/} This has been

^{9/} E. E. Slutsky, "On the Theory of the Budget of the Consumer," in Reading in Price Theory, ed. by G. T. Stigler and K. Boulding (Homewood, Ill.: R. D. Irwin, Inc., 1952).

most commonly referred to as the substitution effect. The second term on the right-hand side of equation (18) is commonly referred to as the income effect. The substitution effect represented within this mathematical framework is the rate at which the consumer will substitute the i -th commodity for other commodities when the price of the i -th commodity changes. Income effects denote the rate of change in the consumption of the i -th commodity per unit change in real income caused by its price change. The sum of both effects gives the total effect on quantity consumed induced by a price change of the i -th commodity.

Slutsky also has shown that cross price derivatives are always symmetric under the assumptions which in turn implies that the residual variability or substitution effect of the j -th commodity for a compensated change in the i -th price is identically equal to the corresponding term for the i -th commodity with respect to the j -th price. Thus,

$$k_{ij} = k_{ji}. \quad (19)$$

Structural Parameters

Demand studies might be classified into two broad categories. ^{10/} One group includes those models explaining the relationship between the

^{10/} Kunio Yoshihara, "Demand Functions: An Application to the Japanese Expenditure Pattern," Econometrica, XVII (April, 1969), pp. 257-274.

dependent variable quantity consumed of a single commodity and the independent variables of its own price, the prices of related commodities, total income and/or other relevant variables. The second group is concerned with the relationship of total expenditure to an exhaustive set of different commodities. Even though there are certain relationships between these two approaches, the emphasis here will generally be concerned with single commodity models.

In the preceding section it was shown how, based on the assumption of consumer's rationality, that an individual demand function for a commodity can be derived and that certain properties can be deduced from these functions. Other useful measures can be derived which have special meaning in economics. These include such measures as elasticity and/or flexibility coefficients of demand.

Elasticities of Demand

Two commonly used elasticity coefficients in demand analysis include price elasticity and income elasticity of demand. Price elasticity of demand can be distinguished into own or direct price elasticity and cross price elasticity. Own or direct price elasticity of demand for x is defined as the proportionate rate of change of x relative to the proportionate rate of change of its own price with income and all other prices, p_i , constant. In equation form,

$$E_{ii} = \frac{\partial(\log x_i)}{\partial(\log p_i)} = \frac{p_i}{x_i} \frac{\partial x_i}{\partial p_i} . \quad (20)$$

The cross price elasticity of demand relates the proportionate change in one quantity relative to the proportionate change in the other price, or

$$E_{ij} = \frac{\partial(\log x_i)}{\partial(\log p_j)} = \frac{p_j}{x_i} \frac{\partial x_i}{\partial p_j} . \quad (21)$$

An income elasticity of a demand function is defined as the proportionate change in the quantity purchased of a commodity relative to the proportionate change in income, with all prices constant, or

$$\pi_i = \frac{\partial(\log x_i)}{\partial(\log I)} = \frac{I}{x_i} \frac{\partial x_i}{\partial I} . \quad (22)$$

The shape and position of the demand function for the i -th commodity depends upon the form of the underlying consumer's utility function. It is generally assumed that demand curves have negative slopes. If the corresponding single commodity demand function is downward sloping then its own price elasticity coefficients (E_{ii}) are negative. Cross price elasticities may be positive, negative, or zero according to whether the relationship of the two commodities in question is a substitute, complement, or independent. Income elasticities can be positive, negative, or zero but are normally assumed to be positive for normal goods and negative for inferior goods.

Flexibilities of Demand

Price flexibility of demand is defined as the proportionate change in the price of i -th commodity associated with a corresponding

change in quantity demanded, all other variables remaining constant.

Cross price flexibility and income flexibility of demand are identically defined, except that it is related to the quantity of the i -th commodity and j -th price in the first and income in the latter. These flexibility coefficients can be written as follows:

$$F_{ii} = \frac{\partial(\log p_i)}{\partial(\log x_i)} = \frac{x_i}{p_i} \frac{\partial p_i}{\partial x_i} \text{ (own price flexibility)} \quad (23)$$

$$F_{ij} = \frac{\partial(\log p_i)}{\partial(\log x_j)} = \frac{x_j}{p_i} \frac{\partial p_i}{\partial x_j} \text{ (cross price flexibility)} \quad (24)$$

$$F_{iI} = \frac{\partial(\log p_i)}{\partial(\log I)} = \frac{x_i}{I} \frac{\partial I}{\partial x_i} \text{ (income flexibility)}. \quad (25)$$

In agricultural economic research it is sometimes easier to obtain the flexibility coefficients from structural parameters than the elasticities. One of the reasons is because for many types of agricultural production processes the quantity supplied to the markets is determined largely in advance of current prices. Consequently, changes in market prices observed are generally functionally related to changes in quantities marketed and changes in income. Depending on the objective of a problem, elasticity estimates might be needed or preferred. This raises the question of how appropriately the inverse of direct price flexibility coefficients represents direct price elasticities. Meinken, Rojko and King state that "... the reciprocal of the price

flexibility . . . equals the price elasticity . . . only if B_{12} and B_{21} (cross effects) are zero." 11/

James P. Houck demonstrates that the inverse of the direct price flexibility is the lower bound, in absolute terms, of direct price elasticity; the inverse of the direct price flexibility is generally not the same as the direct price elasticity; and the stronger the cross effects of substitution and complementarity the further the direct price elasticity will depart from the inverse of the price flexibility. 12/ However, one might argue that as an approximation to the size of the departure of the estimated form, the direct price elasticity coefficients could be evaluated through examination of cross flexibility coefficients. On the other hand, Waugh is of the opinion, " . . . if for any reason the elasticity of demand is wanted, I would prefer to use . . . regression equations, using quantities as the dependent variable . . ." 13/

11/ K. W. Meinken, A. S. Rojko, and G. A. King, "Measurement of Substitution in Demand from Time Series Data: A Synthesis of Three Approaches," Journal of Farm Economics, XXXVIII, No. 3 (1956), p. 734.

12/ James P. Houck, "The Relationship of Direct Price Flexibilities to Direct Price Elasticities," Journal of Farm Economics, XXXVII, No. 3 (1965), pp. 789-792.

13/ F. V. Waugh, "Demand and Price Analysis: Some Examples from Agriculture," U. S. Department of Agriculture Tech. Bul. 1316 (Washington, D. C.: Government Printing Office, 1964), pp. 29-30.

The position taken in this research effort was to structure the estimating equations in the form which seemed best to reflect the functional relationship. This sometimes requires sacrificing standard forms of indicators.

Aggregation Aspects

The demand relationships presented earlier were generally specified on the basis of an individual consumer behavior with a given income facing a given market condition. However, in applied economic research even if one performs analyses starting with the individual consumer, one is generally more interested in the aggregate demand relationships. This is in part due to the fact that decisions of individual consumers do not have significant effects on market prices. It is commonly recognized in economic research that going from the individual to the aggregate may produce an aggregation bias. This implies caution and the necessity for specification of a consistent procedure for aggregation and to further investigate what the nature and magnitude of the aggregation bias might turn out to be for the procedure adopted. Aggregation is defined to be consistent when the use of information more detailed than that contained in the aggregate process would make no difference to the results of the analyses of the

problem at hand. 14/ Conceptual tools to overcome this problem are illustrated by the works of Theil and Allen. 15/ Grunfeld and Griliches 16/ argue that aggregation may produce an aggregation error but it may also produce an aggregation gain due to the possibility of reducing specification errors of individual behavior.

Summary

- 1) Ordinary demand functions state that the quantity consumed of commodity i is a function of all prices and income.
- 2) The demand for any commodity i is a single-valued function of a particular price income set.
- 3) Demand functions are homogeneous of degree zero in income and prices.
- 4) Demand functions are contingent on utility maximization of the consumer or more precisely contingent on continued satisfaction of the equilibrium conditions.

14/ H. A. J. Green, An Aggregation in Economic Analysis: An Introductory Survey (Princeton: Princeton University Press, 1964).

15/ H. Theil, Linear Aggregation of Economic Relations (Amsterdam: North-Holland Publishing Company, 1954); R. G. D. Allen, Mathematical Economics (New York: McMillan Company, 1966), pp. 694-722.

16/ Y. Grunfeld and Z. Griliches, "Is Aggregation Necessarily Bad?," The Review of Economics and Statistics, XLII, No. 1 (1960).

5) The sum of own-, cross-, and income-elasticities of demand for a particular commodity add up to zero.

6) $k_{ij} = k_{ji}$ or that the residual variability or substitution effects of the i -th commodity for a compensating change in the j -th price is symmetric to the corresponding term for the j -th commodity with respect to the i -th price.

7) Demand relationships based on an individual consumer do not necessarily carry over to the aggregate level.

8) In general, the inverse of price flexibilities is not the same as the price elasticities, but is its lower bound in absolute terms.

CHAPTER IV

THE ECONOMETRIC DEMAND MODEL

In the previous chapter the effort was to show the logical foundation of demand functions. There has been continued developments in hypothesis testing related to the postulated properties of the demand function. ^{1/} Also, developments in demand analysis concerned with empirical estimation based on observed facts of the relationships of variables affecting actual consumer behavior have been carried out.

These types of applied studies can be examined from several points of view. First, since applied demand studies involve statistical measurement, emphasis is sometimes placed on the process of measurement itself with respect to questions of statistical methods and techniques. Second, assessing the consistency of model behavior with the existing body of economic theory and vice versa are important econometric issues. Third, from an applied point of view, one may wish to inquire about the end results of a study when judged on the basis with other information and on how it provides a basis for analysis and projection. These points are not mutually exclusive and there will be some of each in the present study.

^{1/} Among others see: R. H. Strotz, "The Utility Tree," Econometrica, XXV, No. 2 (1959), pp. 269-280; H. S. Houthakker, "Additive Preference," Econometrica, XXVIII, No. (1960), pp. 244-257; P. A. Samuelson, "Consumption Theory in Terms of Revealed Preference," Econometrica, XV (November, 1948), pp. 243-253.

The nature of use of the demand function in this study precludes simple extrapolation of past trends. Since projections of the impact of alternative import policies are sought, it is necessary to determine how consumers in the aggregate might be expected to respond to changes in the main economic components (prices, income, etc.) of demand. The appropriate analytical tool to be used is judged to be the econometric approach. This approach allows the estimation of the effect of changes in these economic components upon the relevant structural relationship.

One of the main issues in the econometric approach is to first construct an economic model which has a basis from economic theory and functionally describes the system under investigation. The structural form must allow for proper statistical estimation and lend itself to sound and meaningful economic interpretation. 2/

Causal Relation

In accordance with the requirement of economic theory presented in Chapter III, one can structure a demand system in implicit form with m substitutive and complementary commodities for a given time period

2/ E. J. Kane, Economic Statistics and Econometrics: An Introduction to Qualitative Economics (New York: Harper and Row, 1968) stated this in the following way: "... econometrics covers a specific class of problems in economic statistics: those where statistical methods are applied to theoretical models of economic reality . . ."

as: 3/

$$H(Q,P,Z) = 0$$

where: Q = a $m \times 1$ vector of market clearing quantities of the m commodities;

Z = a $k \times 1$ vector of exogenous shift variables (including income, population, etc.);

P = a $m \times 1$ vector of equilibrium prices associated with the m commodities; and

0 = a $m \times 1$ null vector.

The above specified function does not imply any causal relationship governing the market structure of beef in Japan. Economic theory provides alternative hypotheses relative to demand functions:

$$Q = f(P,Z) \tag{26}$$

or

$$P = f(Q,Z), \tag{27}$$

with the matrices as specified above. The different formulations are consequences of using different behavioral assumptions. Relation (26) is based on the Marshallian assumption while relation (27) is using the Walrasian assumption.

3/ Theoretically all commodities should be included due to inter-relationships of all commodities through the budget constraint. Support for reducing the number of commodities involved can be found in George and King, "Consumer Demand for the U. S.," pp. 21-22.

If prices are assumed non-variable for the time period assumed, perhaps because they are determined outside the system (world market), 4/ then relation (26) is the preferred specification. If the quantity marketed is assumed fixed for a given time period, as is the case for many agricultural products, then relation (27) seems to be a more realistic specification of the cause and effect relationship. 5/

Under the existing policy in Japan, where restrictions are placed on imports of beef, the Marshallian demand specifically would a priori be judged inappropriate to explain the observed behavior of price-quantity adjustments. Prices tended to be more variable over time while quantity consumed was relatively stable. Consequently, the Walrasian concept of demand appeared to more adequately describe the causal relationship effect in Japan.

With regard to supply, a comprehensive investigation is beyond the scope of this study. Supply functions will be taken into consideration insofar as they exercise certain effects on or co-determine demand functions. The causal relationship in supply has always been assumed to be specified such that the dependent variable is quantity.

4/ R. A. Stone, The Measurement of Consumers' Expenditure and Behavior in the United Kingdom (London, England: Cambridge University Press, 1954).

5/ K. A. Fox, "The Analysis of Demand for Farm Products," U. S. Department of Agriculture Tech. Bul. 1081 (Washington, D. C.: Government Printing Office, 1953).

Care must then be employed in the specification of the independent variables in the function.

Choice of Variables

For decisions related to inclusion or exclusion of variables in a model, guidelines are generally in the first instance provided by economic theory considerations and in the second instances by statistical requirements.

To specify those commodities regarded as interrelated with beef consumption, the substitution and complementarity relationship will, as a first approximation, be formulated for the basis of a priori judgment and previous work along similar lines of inquiry. It is assumed for Japan that consumption of pork and chicken are interrelated to beef consumption. Income and population are exogenous variables which logically affect the shifting of the demand function. The effects of the income variable on demand are explained through such theoretical concepts as the Engel curve. Population will not usually affect demand at the individual level but the opposite holds for the aggregate level.

The variable, quantity of beef imported, is designed in this model to be the policy variable, and consequently, it is fixed and exogenous to the system. At this point it might be argued that this variable could be viewed as endogenous to the system described through a function which could reflect the decision process of the Japanese Government, related to variation of that variable.

But after examining the implications more carefully, including several trial computer runs, where quantity imported has been specified as endogenous, it was felt that the first type of specification will more representatively simulate the actual conditions taking effect in Japan. These assumptions will provide an opportunity for testing the assumed relationship through the concepts of elasticities as described in Chapter III.

Another variable which is theoretically important, but usually omitted from the formal model, is the taste variable. It is omitted because of the difficulty in measurement. As a result, this variable is usually assumed to be constant during the period of study or its effect is picked up in part through the use of a trend variable.

With respect to beef supply in this study, the following variables are hypothesized to be relevant: (1) lagged beef prices; (2) lagged herd size; (3) lagged feed grain prices; (4) lagged milk prices; and (6) current beef prices.

It is apparent that the quantity of beef produced in any given year depends on decisions made several years before. This is due to the fact that it requires time to produce and market beef products. The size of the beef producing herd in previous years sets the parameters for its productive capacity for the current year. Lagged feed grain prices are expected to be important to current beef production since it is an input or cost factor. In addition, domestically grown

feed grain can also be viewed as an alternative to beef production in Japan since it competes for the scarce available land.

Since a substantial part of the beef industry of Japan relies upon dual-purpose breeding herds (beef and dairy), lagged milk prices could also be an important variable in the determination of the current amount of beef produced. At the final stages of model formulation, the inclusion of lagged milk prices seems to create statistical problems, due to its collinear relation with the price of barley. Since the price of barley has a dual impact on production, i.e., as an input and as an alternative, it was decided to drop the lagged milk price from the supply equation for beef. If cows are being culled from the dual-purpose breeding herd and slaughtered to produce beef due to attractive current beef prices, this variable also influences beef supply.

If one looks at the more realistic beef production cycles the time lags to be included in a model would probably range over two- to six-year time periods. In this study, the decision of what and how many time lags to include is more of a practical problem than a theoretical one. The small number of data points available forces one to include only the most significant time lags. A time lag of two years was used since it most reasonably represented the significant changes in beef production as related to this influence. Higher order time lags appeared to taper off in magnitude with the resulting losses

in degrees of freedom exceeding the precision gained through specification improvement.

Economic literature makes a distinction between long-run or short-run demand and supply functions. 6/ With respect to structural demand in this study, annual observations are used. Assuming that consumers' adjustment period to price changes occurred in less than one year, there should be no significant difference between short-run and long-run estimates. 7/

With respect to supply, it is assumed that during the generating process of the data some factors of production were fixed, therefore, the observations represent points on a short-run surface. Consequently, the nature of the supply function based on these data would be short-run. A complete variable definition is given in Table V.

The Assumed Structure

It is recognized that the characteristics of the beef market in Japan is more complex than can be modelled and estimated. There are some minor issues which could be included if data were not a serious

6/ Among others see Ruby T. Norris, The Theory of Consumer's Demand (New Haven, Conn.: Yale University Press, 1941) and Marc Nerlove, "Distributed Lags and Demand Analysis for Agricultural and Other Commodities," U. S. Department of Agriculture Agr. Handbook No. 141 (Washington, D. C.: Government Printing Office, June, 1958).

7/ W. G. Tomek and W. W. Cochrane, "Long Run Demand: A Concept and Elasticity Estimates for Meats," Journal of Farm Economics, XXXIV, No. 3 (1962), pp. 720-729.

TABLE V. DEFINITION OF VARIABLES.

Variables	Units	Data Source	Deflator
<u>Endogenous</u> 1/			
P_{bt} = Wholesale price of dressed beef in time t	Kg.	<u>2/</u>	WSPI
Q_{bt}^P = Total annual quantity of beef produced	1000 Metric Tons	<u>2/</u>	Pop.
Q_{pt}^P = Total quantity of pork produced in time t	1000 Metric Tons	<u>2/</u>	Pop.
P_{pt} = Wholesale price of pork at time t	Kg.	<u>2/</u>	WSPI
P_{cht} = Wholesale price of chicken at time t	Kg.	<u>2/</u>	WSPI
<u>Exogenous</u>			
Inc_t = Total national income	Bil. Yen	<u>3/</u>	CPI/Pop.
P_{bt-2} = Wholesale price of dressed beef in t-2	Kg.		
$Catt_{t-2}$ = Number of cattle in t-2	1000 Head	<u>3/</u>	
$P_{bar_{t-2}}$ = Wholesale price of barley in t-2	Kg.	<u>2/</u>	
P_{ft} = Wholesale price of fish in t		<u>2/</u>	WSPI
Q_{cht}^{DS} = Total quantity of chicken clearing the market in time t	1000 Metric Tons	<u>2/</u>	Pop.
Q_{bt}^M = Total quantity of beef imported	1000 Metric Tons	<u>2/</u>	Pop.
P_{pt-2} = Wholesale price of pork in t-2	Kg.	<u>2/</u>	
Q_{pt-2}^P = Total quantity of pork produced in t-2	1000 Metric Tons	<u>2/</u>	

1/ If these variables appear in any supply equation, its nominal un-deflated value is used. Population data are obtained from source 3/, while Consumer Price Index (CPI) and Wholesale Price Index (WSPI) are obtained from source 2/.

2/ Japan, Ministry of Agriculture and Forestry, "Demand and Supply of Food and Price of Food," "Wholesale Price of Foodstuff," Statistical Yearbook (Tokyo: various issues).

3/ Japan, Bureau of Statistics, Office of Prime Minister, "National Accounts," "Population," Statistical Yearbook (Tokyo: var. issues).

constraint. These include the amount of beef used for industrial purposes, stocks, or lost to processing waste. This is assumed negligible. Animal food usages, except of marine origin, are relatively "novel" in Japan. Consequently, it is assumed that consumers' preferences within the meat group can be realistically partitioned into beef, pork, and chicken.

The exclusion of quantity or price variables of substitutes from the beef demand relation is to cope with statistical problems of multicollinearity. A unique example in the present study is fish consumption which was found to be heavily collinear with several other variables, preventing its cross elasticity coefficients with commodities in the meat group from being obtained. Cross relationships within the meat group can be further obtained from the respective demand relations of chicken and pork which are justified on the basis of the use of the symmetry assumptions among commodities. Quantity of beef clearing the market is partitioned into quantity produced domestically and imports. The inclusion of the price of fish in the demand equation is aimed at establishing the substitution relationship. Unfortunately, the model will not be able to indicate the magnitude of this relation.

Beef Demand Relation

The following beef demand relationship is postulated:

$$P_{bt} = f(Q_{bt}^P, Q_{bt}^M, Inc_t, P_{ft}, Q_{ch_t}^{DS}) \quad (28)$$

where all variables are as defined in Table V. Under a priori conditions, it would be expected that the price of beef will change inversely with quantity of beef demanded and will increase directly with income and population. Therefore, the following conditions will hold with respect to the partial derivatives:

$$\frac{\partial P_{bt}}{\partial Q_{bt}^P} < 0, \frac{\partial P_{bt}}{\partial Q_{bt}^M} < 0, \frac{\partial P_{bt}}{\partial Inc_t} > 0, \frac{\partial P_{bt}}{\partial P_{ft}} > 0, \frac{\partial P_{bt}}{\partial Q_{ch_t}^{DS}} < 0.$$

Domestic Beef Supply Relation

Adjustment of supply from domestic sources is constrained by capacity factors and the conventional characteristics of Japanese livestock industry. Cattle raising for direct beef production is not very common. A substantial amount of cattle slaughtered come from the dairy industry either as a result of the current price or as a result of lagged beef prices. Herd reduction occurs as a result of current high prices with breeding cows being marketed as beef. This practice has an intertemporal impact on capacity to produce.

The following relation represents the beef supply equation:

$$Q_{bt}^P = f(P_{bt}, P_{bt-2}, Catt_{t-2}, P_{bar_{t-2}}) \quad (29)$$

where all variables are as defined in Table V.

A priori conditions indicate that the quantity of beef supplied will change in the same direction as current beef prices, prices in

$t-2$, number of cattle in $t-2$; the last two variables indicating expectation and continuity of production, while it will change inversely with prices of an input factor and competing product in terms of resource use. Using partial derivatives, the above implies

$$\frac{\partial Q_{bt}^P}{\partial P_{bt}} > 0, \frac{\partial Q_{bt}^P}{\partial P_{bt-2}} > 0, \frac{\partial Q_{bt}^P}{\partial Catt_{t-2}} > 0, \frac{\partial Q_{bt}^P}{\partial P_{bar_{t-2}}} < 0.$$

Pork Demand Relation

Pork is also considered to be in the "other meat group" with respect to beef in the Japanese consumption pattern. Therefore, as in the case of chicken it is expected to be a substitute for beef. The following relationship is specified as being descriptive with respect to Japanese pork consumption:

$$P_{pt} = f(P_{bt}^P, Q_{pt}^P, Inc_t, P_{ft}), \quad (30)$$

where all variables are as defined in Table V.

It is a priori expected that the following relationships hold with respect to their partial derivatives for equation (30):

$$\frac{\partial P_{pt}}{\partial P_{bt}} > 0, \frac{\partial P_{pt}}{\partial Q_{pt}} < 0, \frac{\partial P_{pt}}{\partial Inc_t} > 0, \frac{\partial P_{pt}}{\partial P_{ft}} > 0.$$

Domestic Pork Supply Relation

The formulation of this relation is based on the assumption that import of pork does not significantly affect the price determination of pork. Pork production has greatly expanded during the sample period. The postulated relationship is:

$$Q_{pt}^P = f(P_{pt}, P_{pt-2}, Q_{pt-2}^P, P_{bar_{t-2}}) \quad (31)$$

where all variables are as defined in Table V.

The partial derivatives in this relation are expected to have the following signs:

$$\frac{\partial Q_{pt}^P}{\partial P_{pt}} < 0, \frac{\partial Q_{pt}^P}{\partial P_{pt-2}} > 0, \frac{\partial Q_{pt}^P}{\partial Q_{pt-2}^P} > 0, \frac{\partial Q_{pt}^P}{\partial P_{bar_{t-2}}} < 0.$$

Chicken Demand Relation

The formulation for demand for chicken is aimed at obtaining some information about cross effects with beef. For the past five years, the consumption of chicken has increased faster than the consumption of beef. The postulated relationship is:

$$P_{ch_t} = f(P_{bt}^P, Q_{ch_t}^P, Inc_t) \quad (32)$$

where all variables are as defined in Table V.

It is a priori expected that the following relationship holds with respect to the partial derivatives for equation (32):

$$\frac{\partial P_{ch_t}}{\partial P_{bt}} > 0, \frac{\partial P_{ch_t}}{\partial Q_{ch_t}} < 0, \frac{\partial P_{ch_t}}{\partial Inc_t} > 0,$$

Note that all partial derivatives of demand functions, with respect to income, are postulated to be positive. This results in part because consumption of meat products has a very recent history and is considered luxurious. Therefore, the amount consumed will change in the same direction as income. This relationship of positive income elasticity has been observed in every country in which analyses of this kind have been carried out. In the above formulations, all quantities are assumed to be predetermined except in the case of beef and pork.

The simultaneity relationship of beef and pork production in conjunction with beef demand and pork demand is indicated by the cyclic movement of beef and pork production over time as depicted in Figure 2. Adoption of the assumption is due to practical data and specification knowledge rather than implied by economic theory.

Data Adjustment

The basic data source used for the estimation of the five postulated relationships of the Japanese beef market system were generally taken from the various issues of the Statistical Yearbook of the

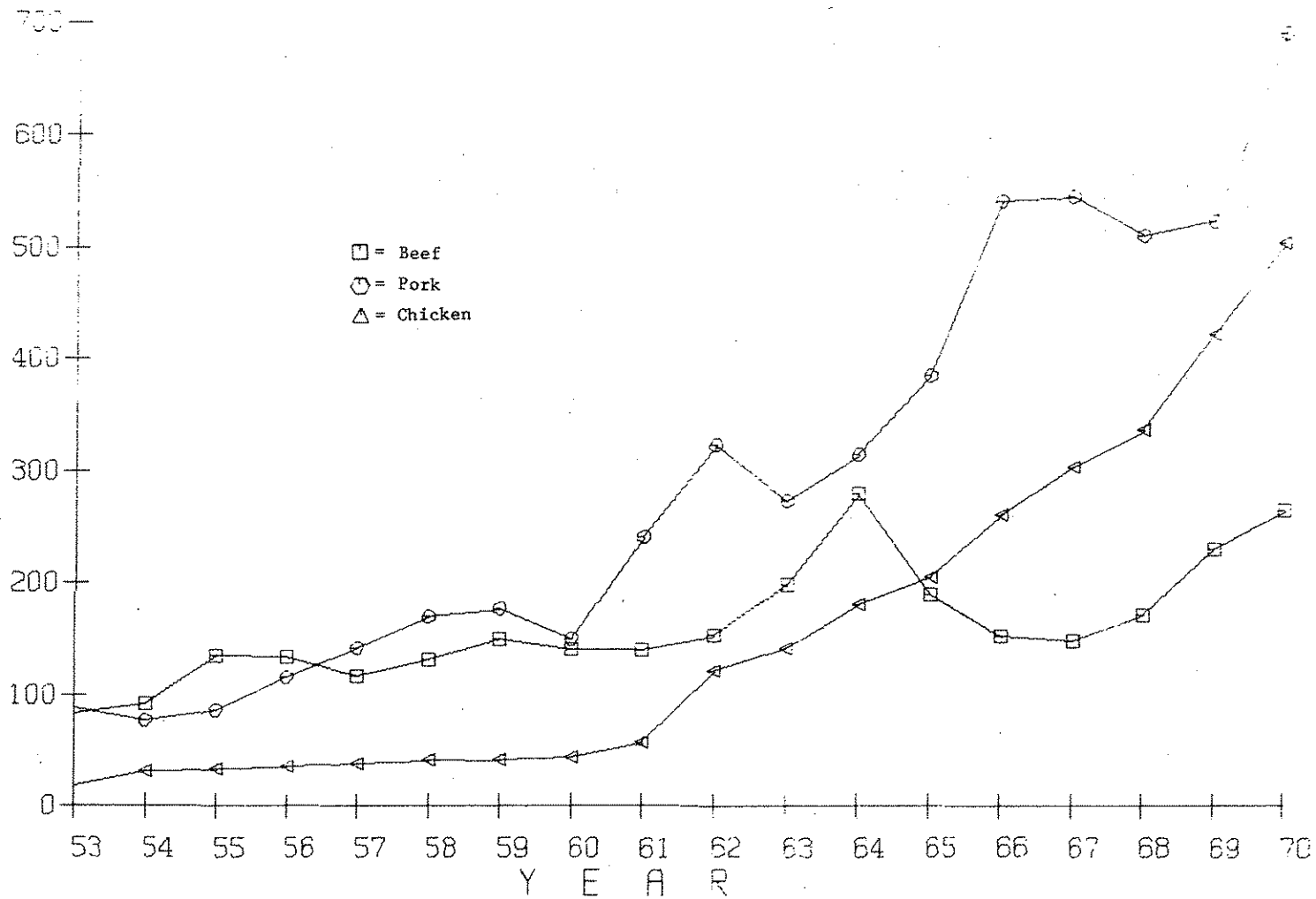


Figure 2. Japan: Production of Beef, Pork, and Chicken (000 Metric Tons).*

*Source: Computed from Appendix Tables I, II, and III.

Ministry of Agriculture and Forestry, and the Japan Statistical Yearbook published by the Bureau of Statistics, Office of the Prime Minister. 8/ The period covered was 1953-1970 furnishing 18 annual observation data points. The detailed source of information can be found in footnotes accompanying tables and graphs of the numerical sample data given in Appendix Tables I, II, III, and IV.

Price variables used in this study are wholesale prices and quantities and are expressed in carcass equivalent weight units of dressed beef. Since the ultimate analysis is based on the Japanese demand for beef in the world market, wholesale prices were used with the assumption of constant (over time) marketing differentials down through the market outlet chain.

In most demand studies for meat products, difficulties arise due to grades and quality differences of the commodities under analysis and problems of averaging out locational price differences to obtain a reasonable consumer market price variable. It was believed that an analysis centered on the wholesale level could alleviate some of the difficulties since quality differences are automatically averaged out, while the number of wholesale markets are definitely less than retail markets thus eliminating undue spatial difficulties.

With regard to deflation procedures, the Consumer Price Index will be used to deflate income, while the Wholesale Price Index will be used

8/ See Table V.

to deflate wholesale prices. Although there are admittedly theoretical inconsistencies associated with using more than one deflator in a given model, the above procedure is preferred. It was found that this provided more and better information in relation to the given data set.

Although the problems of using time series data have been properly recognized, such as the assumption of no structural change over time, it is still claimed that the methodology employed best suits the primary goals of this study. ^{9/} A cross-section analysis, unless supported with rigid assumptions, does not provide the desired information on influences of prices. It has been increasingly realized that elasticity coefficients obtained from cross-section and time series data are conceptually different, and that the latter are more appropriate for analytical purposes of price influences or projections which are some of the primary objectives of the study.

Another important feature of the foregoing structural system is that all prices and quantity variables in every supply relation are left undeflated so as to conform to the assumption that producers in Japan are making their decisions based on observed nominal prices.

^{9/} Houthakker and Taylor discussed the problems of serial correlation and the isolation of trends in time series analysis. (H. S. Houthakker and L. D. Taylor, Consumer Demand in the United States, 1929-1970: Analysis and Projections (Cambridge, Mass.: Harvard University Press, 1966).)

CHAPTER V

STATISTICAL ESTIMATION

As a frame of reference in estimation, most econometric models can be expressed in a general matrix notation as follows:

$$B(Y'_t - \varepsilon_t) + \Gamma(X'_t - \sigma_t) = U_t. \quad (33)$$

The above model is said to be in structural form and the variables constrained by this equation consist of:

- 1) g dependent variables Y ; Y'_t is a vector of observed values at time t ;
- 2) k explanatory variables X (including lagged dependent variables); X'_t is a vector of observed values at time t ;
- 3) $(g + k)$ residual variables ε and σ representing errors of measurement; ε_t and σ_t for time t ;
- 4) g residual variables U representing the joint effects of neglected explanatory variables; U_t for time t ; and
- 5) B and Γ are matrices of parameters to be estimated. It is ordinarily assumed and necessary for solution that the matrix B has an inverse.

The above formulation must be more restricted to facilitate estimation. 1/ The residuals ε , σ and U are usually considered not

1/ Marschak remarks that, "Too often economic theory is formulated in terms of exact relations, with the frustrating consequence that it is always contradicted by facts. If the numerous causes that cannot be accounted for separately are appropriately accounted for in their joint effects as random disturbances, statistical prediction in a well defined sense becomes possible." Jakob Marschak, "Economic Measurements for Policy and Prediction," Studies in Econometric Methods, Cowles Commission Monograph No. 14 (New York: John Wiley & Sons, Inc., 1953), p. 14.

observed nor known. There is no well established method to estimate the magnitude of ϵ and σ nor statistical properties of the estimates of the parameters when these are assumed not to be zero. However, if certain assumptions about U and its distribution are postulated, then statistical properties of the estimators are well known and hypothesis testing and interval estimation have a probability basis.

In order to obtain a more powerful practical model which can be estimated, the following assumptions are added:

- 1) the random residuals ϵ and σ are negligible; and
- 2) the random residuals U are independent from X but not from Y , and they are normally distributed with fixed parameter matrices

$$\begin{aligned} E(U) &= 0 & i &= 1, \dots, r \\ E(UU') &= \sigma_{ij}^2 I & j &= 1, \dots, k. \end{aligned} \quad (34)$$

Employment of the above assumptions yields the following structural model:

$$BY'_t + FX'_t = U_t. \quad (35)$$

Based upon the assumed structure of the beef market in Japan, the model can be estimated by Ordinary Least Squares, Limited Information or Full Information estimation methods.

Form of the Function

Economic theory states that the quantity demanded of a particular commodity is a function of its price, prices of related commodities,

and income. But this theory gives little suggestion of the shape of the curve which results from this functional specification. The problem of finding the most appropriate equation form is an old one in econometrics, but as yet no specific solution appears to have found general acceptance. There are two general problems associated with specifying the functional form of demand. First, the necessity to satisfy the restrictions as specified for theoretical demand functions. Second, the almost insurmountable estimation difficulties presented by some of these functions.

Two sets of such functions which have found wide empirical application in demand analysis have been considered for the present study. These functions are: (1) the double log function and (2) the linear function. The use of these functions has been frequently criticized for their lack of congruence with certain theoretical postulates or practical logic. The double log function implies a constant elasticity assumption. Although this assumption is convenient methodically, it could be expected to be true only over a short range of prices. When working with a time series data base, typically goods which are luxurious at the beginning of the series gradually become necessities as income increases over time. A more basic problem is that if all income elasticities are constant, those goods with elasticities greater than unity, would, as real income increases, come to dominate the budget

and eventually would lead to the controversy that the sum of expenditures on each commodity would exceed total expenditure.

The linear demand model perhaps claims precedence among demand models in popularity and frequency of use. ^{2/} The implication of a very restrictive assumption of additive utility between commodities is one of its main weaknesses since in most studies this assumption was not confirmed. Usually the goodness of fit for the linear demand model is less than the double log model. Another important advantage of linear models is computational simplicity and its simple interpretation for policy makers for predictive purposes. The marginal aspects are apparent by simple inspection. With a few exceptions investigators in the past, if frequency of use is an indicator, seem to have been satisfied with the use of linear models for demand analysis. ^{3/} After careful consideration of the above factual consequences it was felt

^{2/} It should be noted that the double log function is linear in the parameters from an estimation viewpoint. The linear demand model referred to here is linear in functional specification and, of course, is also linear in the parameter estimation sense.

^{3/} A. S. Goldberger and T. Gamaletson, "A Cross Country Comparison of Consumer Expenditure Patterns," European Economic Review, I (1970); H. S. Houthakker, "An International Comparison of Household Expenditure Patterns, Commemorating the Century of Engel's Law," Econometrica, XXV (October, 1957); S. Yamashita, "An Exploration of the Economics of Taste and Demand for Food" (unpublished Ph.D. dissertation, University of Minnesota, July, 1973).

that the linear demand model using absolute values of variables is best suited to the Japanese condition.

The Functional Relationship

Five relationships were formulated for the model in the preceding section. It was claimed that these economic relationships, which were specified as exact determinants, could be handled as stochastic functional relationships among the defined variables so as to facilitate statistical estimation. It must be recognized that postulated relations will, in general, never include all the relevant variables that might have impact on the system. Only variables for which reliable empirical data are available can be estimated in each relation. Other variables were left aside intentionally on an a priori basis or unintentionally because of ignorance about the system. These excluded influences become non-specified disturbances to the system and not only affect but influence the size of the disturbance term U_{it} . There are five endogenous variables and nine exogenous variables specified for the systems of relations as postulated in the previous chapters.

A summary of data sources is also provided in Table V. The last column indicates the kind of deflater used.

The Structural Form

The complete structural relations of the model can be summarized and written in the following matrix form:

$$AY_t + BX_t = U_t \quad (36)$$

where: the vector of endogenous variables is:

$$Y_t = \begin{bmatrix} P_{bt} \\ P \\ Q_{bt} \\ P_{pt} \\ P \\ Q_{pt} \\ P_{ch_t} \end{bmatrix}$$

the vector of exogenous variables is:

$$X_t = \begin{bmatrix} Inc_t \\ P_{ft} \\ M \\ Q_{bt} \\ DS \\ Q_{ch_t} \\ P_{bt-2} \\ Catt_{t-2} \\ P_{bar_{t-2}} \\ P \\ Q_{pt-2} \\ P_{pt-2} \end{bmatrix}$$

the matrix of parameter coefficients for the endogenous variable is:

$$A = \begin{bmatrix} 1 & a_{11} & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 \\ a_{31} & 0 & 1 & a_{33} & 0 \\ 0 & 0 & a_{43} & 1 & 0 \\ a_{51} & 0 & 0 & 0 & 1 \end{bmatrix}$$

the matrix of parameter coefficients for the exogenous variables is:

$$B = \begin{bmatrix} b_{11} & b_{12} & b_{13} & b_{14} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & b_{25} & b_{26} & b_{27} & 0 & 0 \\ b_{31} & b_{32} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & b_{47} & b_{48} & b_{49} \\ b_{51} & b_{52} & 0 & b_{54} & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

Two distinctive features of the above formulated models should be noted. First, the matrix of parameter coefficients of the endogenous variables, A, is not a triangular matrix and second, the vector associated with parameter coefficients for lagged endogenous variables is not a null vector.

By definition, a structural system is recursive ^{4/} if the matrix of parameters of the endogenous variables is triangular, and a structural system is called dynamic if the matrix associated with the lagged

^{4/} P. J. Dhrymes, Econometrics: Statistical Foundations and Applications (New York: Harper and Row, 1970), p. 305.

endogenous variables is not null. Therefore, the formulated structural system above is essentially a non-recursive dynamic system.

The Reduced Form

In view of the objectives of this study it is important to consider the short-run impact multipliers as well as the structural form. Short-run multipliers are reflected through the effects of the exogenous and predetermined variables on the endogenous variables. Short-run impact multipliers are derived from the reduced form of the model's equation system. The reduced form of this research effort will be used for predictive purposes as well as to present the impact of a marginal change in the exogenous/predetermined variables on the endogenous variables.

Given the structural form

$$AY_t + BX_t = U_t,$$

the following reduced form can be obtained:

$$Y_t = \pi X_t + V_t$$

where: $\pi = -A^{-1}B$

$$V_t = A^{-1}U_t.$$

In this form one obtains a clear-cut definition of the causal relationship because every endogenous variable is now expressed in terms of exogenous and predetermined variables.

Through partial differentiation of Y_t with respect to X_t , one obtains the reduced form coefficient matrix π . These elements are the partial derivatives of the i -th endogenous variable, Y_{it} , in the vector Y_t with respect to the j -th exogenous variable, X_{jt} . The reduced form coefficient matrix, π , is the marginal impact matrix since it represents the effect of a marginal change of the j -th exogenous variable on the i -th endogenous variable during a given time period. Such coefficients are used for making conditional predictions of the endogenous variables given changes of the exogenous variables.

Estimation Methods

The Ordinary Least Squares (OLS) estimation procedure can be used for equation estimation if the system is recursive and the classical assumption of independent and normally distributed errors having constant variance is used. The last set of assumptions implies that the system has a diagonal error variance-covariance matrix with all zeroes off the major diagonal. ^{5/}

The formulated model is non-recursive, implying a diagonal error variance-covariance matrix does not exist because of interdependent consumption decisions. As a result the OLS estimation method was not statistically appropriate. It can be shown that this procedure will

^{5/} Ibid., pp. 305-308.

yield inconsistent and biased estimates. 6/ Consequently, the appropriate method to use is the simultaneous equation estimation method. 7/

The simultaneous estimation method is applicable if the system of equations is formulated from a mathematically complete model and is identified. Application of the relevant rules revealed that the system of equations set up earlier is mathematically complete and over-identified. 8/

There are many individual estimation methods which are conceptually justified to be applicable for estimation of over-identified systems. But all these methods can be classified into full information or limited information. The full information method implies that the whole system is simultaneously estimated, within the restrictions of all equations in the system. The most frequently used method in this class is the Three-Stage Least Squares method.

For this study the full information procedure was not used since the method is sensitive to specification errors. Specification errors in one of the equations will carry its undesirable impact on the results of estimates obtained for other equations.

6/ J. S. Cramer, Empirical Econometrics (Amsterdam: North Holland Publishing Co., 1969), pp. 204-208.

7/ F. V. Waugh, "The Place of Least Squares in Econometrics," Econometrica, XXIX, No. 3 (1961), pp. 388-389.

8/ For detailed description related to definitions and requirements for mathematical completeness and identification of systems of equations, see R. J. Wonnacott and T. H. Wonnacott, Econometrics (New York: John Wiley and Sons, Inc., 1970).

Another problem in full information methods is the need for a larger sample size in order to remedy the problem of too few degrees of freedom. This is because the whole array of parameters in all equations is estimated in one pass. From a theory viewpoint, the full information method is asymptotically more efficient than the limited information method. For the present study, due to lack of the necessary information especially with respect to production and import relations, aggravated by the small sample size, it was necessary to use the limited information estimating technique.

The following methods are classified as limited information techniques:

- 1) Limited Information/Least Generalized Variance (LI/LGV);
- 2) Limited Information/Maximum Likelihood (LI/ML);
- 3) Limited Information/Least Variance Ratio (LI/LVR);
- 4) Least Weighted Variance (LWV); and
- 5) Two-Stage Least Squares (2-SLS).

The first three methods will conceptually lead to the same estimates. And they share a common feature with the LWV method for not requiring prior information as to which variable is treated as dependent. Estimation is done in a restricted sense describing the desired relationship among relevant variables. ^{9/} Since use has been made of

^{9/} Wonnacott and Wonnacott, Ibid., pp. 372-373.

prior information in this study, to justify relationships in the system, especially with respect to the demand relation for beef, the 2-SLS method was used.

The 2-SLS method is regarded as the simplest solution to the problem of over-identification since it involves estimating only one equation at a time. By repeating this procedure for every equation, the whole system can be estimated without sacrificing degrees of freedom. The resulting properties of the estimates obtained will be consistent and asymptotically efficient.

CHAPTER VI

THE ESTIMATES

Estimates obtained for the structural parameters using the 2-SLS estimation method are presented below. ^{1/} The figures in the parentheses are the standard errors of the estimated parameters. The standard error of the estimates cannot be interpreted in the strict sense of small sample statistical hypothesis testing since information is only known about their asymptotic properties. However, these estimates do provide information at little cost and are provided for relative indicators of precision.

Estimated Beef Demand Function

$$P_{bt} = 147.6 - 141.2Q_{bt}^P - 297.5Q_{bt}^M + 1.462Inc_t - 48.91Q_{ch_t}^S + 4.673P_{ft}$$

(23.34) (101.3) (.3644) (3.501) (.9320)

Estimated Domestic Beef Supply Function

$$Q_{bt}^P = -356.3 + .04634P_{bt} + .8476P_{bt-2} + .2218Catt_{t-2} - 5.322P_{bar_{t-2}}$$

(.1093) (.1405) (.04958) (.2142)

Estimated Pork Demand Function

$$P_{pt} = 41.77 - 92.77Q_{pt}^P + .9339P_{bt} + .3368Inc_t + 2.89P_{ft}$$

(29.13) (.2982) (.3879) (1.345)

^{1/} These estimates were obtained using a program for computing 2-SLS estimates including the associated statistics written originally by Stroud, Zellner, and Chau, modified by S. Townsend for adaptation to the Montana State University XDS Sigma 7 computer.

Estimated Domestic Pork Supply Function

$$Q_{pt}^P = 301.4 - 1.074P_{pt} + 1.219Q_{pt-2}^P + 1.4P_{pt-2} - 7.155P_{bar_{t-2}}$$

(1.993) (1.019) (.3784) (9.974)

Estimated Chicken Demand Function

$$P_{cht} = 50.81 + .3808P_{bt} - 134.8Q_{ch}^S + .8989Inc_t + 1.264P_{ft}$$

(.1738) (23.86) (.2646) (.6288)

The above equation system is presented in matrix notation in Appendix Figure 1.

Estimation Results Using OLS

For purposes of comparison as well as to obtain additional summary statistics, each equation above was also estimated by the OLS estimation method. ^{2/} Although no strong indicators were expected, an effort was made to assess the system from the viewpoint of assumptions related to error distribution and specification. The following estimates were obtained:

Beef Demand Function

$$P_{bt} = 142.6 - 108.7Q_{bt}^P - 254.1Q_{bt}^M + 1.299Inc_t + 3.996P_{ft} - 37.69Q_{cht}^S$$

(17.21) (99.41) (.327) (.8099) (31.69)

$R^2 = .9652$ $D = 1.935$

^{2/} R^2 , t-value of the estimates, and Durbin-Watson Statistics.

Domestic Beef Supply Function

$$Q_{bt}^P = -320.1 - .02651P_{bt} + .8862P_{bt-2} + .2058Catt_{t-2} - 5.038P_{bar_{t-2}}$$

$$(.1019) \quad (.1373) \quad (.04828) \quad (2.107)$$

$$R^2 = .8065 \quad D = 2.078$$

Pork Demand Function

$$P_{pt} = 132.6 + .4562P_{bt} - 65.10Q_{pt}^P + .4103Inc_t + 2.656P_{ft}$$

$$(.157) \quad (4.751) \quad (.1258) \quad (.827)$$

$$R^2 = .7070 \quad D = 1.384$$

Domestic Pork Supply Function

$$Q_{pt}^P = 351.4 - 1.173P_{pt} + 1.269Q_{pt-2}^P + 1.383P_{pt-2} - 7.631P_{bar_{t-2}}$$

$$(.2849) \quad (.1623) \quad (.1802) \quad (2.915)$$

$$R^2 = .9752 \quad D = 1.954$$

Chicken Demand Function

$$P_{cht} = 66.05 + .2626P_{bt} - 134.40Q_{cht}^S + .9782Inc_t + 1.46P_{ft}$$

$$(.09618) \quad (22.93) \quad (.2369) \quad (.5505)$$

$$R^2 = .7564 \quad D = 2.047$$

Reduced Form of the Structural Model

Coefficients of variables in the structural form are direct indicators of the importance of those variables in relation to the dependent variable. Due to the implicit nature of the structural form, it is not possible to record total responses of endogenous variables to particular changes in all the exogenous variables. In this study, the concern is

primarily with prediction and movement of future prices as affected by assumed changes in the beef import variable (Q_{bt}^M). The information needed will require the equation system to be placed in the reduced form. The following reduced form equations are expressed as $Y_t = \pi X_t$ and are shown in Appendix Figure 2.

The most important and distinctive feature of the reduced form is its impact multiplier matrix. ^{3/} This matrix records a one period response or a marginal response of all endogenous variables with respect to a change in one or more exogenous variables. This will allow the accounting for all direct and indirect effects of exogenous variables on a particular endogenous variable in a simultaneous relationship.

Statistical Consideration of Results

The major economic analyses will be based upon estimates derived by 2-SLS procedures. Some comparisons of these estimates will occasionally be made with those derived by OLS but the primary analysis and conclusions are based on the 2-SLS parameter estimates. Some relationships are consistent regardless of the estimating procedure such as the positive relation between demand for a commodity and income.

In other cases there are differences which are not easily explained such as when the coefficients of 2-SLS are somewhat higher than that

^{3/} Goldberger, Impact Multipliers and Dynamic Properties of the Klein-Goldberger Model (Amsterdam: North Holland Publishing Co., 1959).

obtained through OLS. In about half of all cases, the ratio of the estimate to its respective standard error is higher for 2-SLS. It must be remembered that this is only an approximate estimate of its asymptotic variance. Detailed statistical comparison between the two estimating procedures is not an issue that will be pursued in this effort.

Economic theory suggests that employment of simultaneous relations will allow one to obtain a total demand response curve instead of a partial demand curve. 4/ One of the reasons for preferring the total demand response function is for predictive purposes, while the partial demand function is used more for explanatory purposes with ceteris paribus restrictions.

Beef Demand Relation

An inverse relationship was observed between beef prices (P_{bt}) and the per capita quantity of beef clearing the market. Note that this market clearing quantity is broken down into domestic production (Q_{bt}^P) and imports (Q_{bt}^M).

The coefficients for the price of fish (P_{ft}) and quantity of chicken clearing the market ($Q_{ch_t}^{DS}$) confirmed that commodity-wise, they are substitutes for beef. 5/

4/ R. C. Buse, "Total Elasticities--A Predictive Device," Journal of Farm Economics, XL, No. 4 (1958).

5/ This conclusion of a substitute relationship was based on the criterion that cross price elasticity of substitutes should be negative

Domestic Beef Supply Function

For the 2-SLS estimating procedure, the current market price of beef explaining the variance of quantity of beef domestically supplied carried a small but positive estimated coefficient. The OLS estimate had a negative coefficient and was not statistically significant from zero. Taken at face value, these estimated results would appear as being in disagreement with each other. The 2-SLS result is assumed to confirm the simultaneity of supply and demand for beef in Japan, while OLS is assumed to be an example of the weakness of attempting to estimate a simultaneous relationship with statistical methods that do not account for joint dependency.

Pork Demand Relation

There was a positive relationship established between the real price of beef (P_t^b) and real per capita income (Inc_t) with the real price of pork. A negative relationship was observed between price of pork

or: $\partial P_i / \partial Q_j \cdot Q_j / P_i < 0$. Since $\partial P_i / \partial Q_j$ could not be obtained directly from the equation, this term was approximated by:

$$\frac{\partial P_i}{\partial Q_j} = \frac{\partial P_i}{\partial P_j} \cdot \frac{\partial P_j}{\partial Q_j}$$

For normal goods, $\partial P_j / \partial Q_j < 0$, then if $\partial P_i / \partial P_j > 0$, commodity i and commodity j are substitutes, while if $\partial P_i / \partial P_j < 0$, they are complements. With respect to the above equation, this criteria is applicable to: (1) $\partial P_{bt} / \partial P_{ft}$ in the beef demand function; (2) $\partial P_{pt} / \partial P_{bt}$ and $\partial P_{pt} / \partial P_{ft}$ in the pork demand function; and (3) $\partial P_{ch_t} / \partial P_{bt}$ and $\partial P_{ch_t} / \partial P_{ft}$ in the chicken demand function.

(P_{pt}) and quantity of pork demanded from domestic sources (Q_{pt}^P). Other variables in this equation possess the a priori correct signs. Both OLS and 2-SLS yield a relatively small coefficient for the income variable. It is partly a multicollinearity problem but also could indicate that income increases have less impact on the consumption of pork than on the consumption of beef.

Domestic Pork Supply Relation

Except for the current price of pork (P_{pt}), all other variables in the estimated pork supply equation had the correct a priori signs associated with the independent variables. For both the 2-SLS and OLS procedures, the estimated coefficient for the current price of pork was negative. Several interpretations of these signs are possible. In the context of a simultaneous system, Marsh showed similar results for the supply relationship of pork in the United States and the Pacific Northwest region. ^{6/} The rationale is offered for this negative coefficient in a later section concerned with economic analysis of the results.

Chicken Demand Relation

In this relation all variables have the expected signs in accord with economic theory. Both the OLS and 2-SLS estimating procedures confirmed all postulated relationships expressed previously.

^{6/} J. M. Marsh, "An Economic Analysis of the Relationship of the Pacific Northwest and National Livestock Sector" (unpublished Ph.D. Dissertation, Washington State University, 1974).

Inherent Statistical Problems

Major statistical problems (including specification errors) which received attention were serial correlation and multicollinearity. With regard to serial correlation, the Durbin-Watson statistic obtained from the OLS estimate of pork demand indicated the hypothesis of $\rho > 0$ could not be either rejected or accepted at the 5 per cent probability level. 7/ The Durbin-Watson statistic yielded a value that fell in the inconclusive area at the 5 per cent significance level.

Another important statistical assumption in the regression procedure is that there are no exact linear relations among the observed values of the exogenous variables. Exact linear relationships are highly improbable when using raw data but the general interdependence of economic phenomena may result in approximate linear relations. This results in the problem of multicollinearity.

The most predictable consequence of multicollinearity is that the estimates of the standard errors of the coefficients are high which impaired the relative precision one might attach to a particular estimate. 8/

7/ ρ = serial correlation coefficient.

8/ For more detailed description in regard to multicollinearity, see Wonnacott and Wonnacott, Econometrics.

In the process of model development for this study, specifications in order to reduce the multicollinearity effects were considered as an important component. Omission of certain substitute commodity variables from the beef demand function is an example of this problem. Often decisions on inclusion or exclusion of variables from an equation were made on the basis of a trade-off between a theoretically desired specification and the reduction of multicollinearity.

In econometric literature, there exists several proposed solutions to the problem of multicollinearity. Yet no unique solution has received general acceptance. It was not deemed feasible to apply these proposed solutions to this study because of their complexity of computation and in most cases a simple lack of required information.

The R^2 statistics (coefficients of determination) for the important equations in the system (beef demand and beef supply functions) are indicative of a good fit. Less satisfactory results were obtained for the pork and chicken demand equations, with R^2 's of .7070 and .7564, respectively. These were the lowest R^2 values obtained among the equations of the system.

Evaluation of the magnitude of the obtained coefficient estimates requires understanding the variable measurement units. The magnitude of these coefficients is dependent upon the selection of units used in the regression. Therefore, the use of flexibility and elasticity coefficients discussed in a later section serve in comparing relative

effects among changes in exogenous variables because flexibility and elasticity coefficients express relationships in percentage terms.

Analysis of Structural Parameters

From the estimated demand relationships, price and income flexibility coefficients can be derived. Direct price and income elasticity estimates are generally not available. These estimates are compared with results of previously published studies.

There are few demand studies related to beef consumption in Japan which are published in the English language. 9/ Most of these studies differ considerably in scope and objectives. One of the studies which has a reasonable degree of comparability was conducted by Filipello. 10/

9/ Kaneda covers the period 1951-1964. Using per capita food expenditure as the dependent variable and total personal expenditure as the independent variable, he obtained an income elasticity of demand (computed at the mean sample values) for food of .808 when tobacco and soft drinks were included in the food group and .69 when these commodities were excluded. (Kaneda, "Long Term Changes in Food Consumption Patterns in Japan.") Yuize covers the period 1951-1960 using per capita consumption of beef as the dependent variable and annual average retail price, per capita national income as independent variables. He obtained a price elasticity of demand of -.924 and an income elasticity of 1.046, also computed at the sample means. (Yuize, "The Demand for Meat, Milk and Eggs.")

10/ Filipello also used annual wholesale price data covering the period 1953-1965 while as a quantity variable he used per capita net food consumption. The present study is using per capita food disappearance which is considered more consistent with the wholesale market level. The model employed by Filipello consists of 12 estimating equations and 10 identities. (Filipello, "A Dynamic Econometric Investigation.")

A serious problem of comparison of structural parameters is that conceptually there is no such thing as a unique elasticity or flexibility coefficient. The structural parameter estimates usually differ with different model assumptions, the range of the time series data, and differences in estimates resulting from alternative statistical procedures. Table VI is presented to indicate the price flexibility coefficients obtained in this study using 2-SLS and OLS comparing these results with those obtained by Filipello using 3-SLS and OLS. Except for the income flexibility coefficient for pork, the estimates obtained by 2-SLS in this study are higher in absolute value than either Filipello's 3-SLS or OLS estimates. This could be explained by the fact that this study utilized a longer time series period. This could support the hypothesis that in the long run people might adjust more freely to changes, because there are fewer constraints. Samuelson explains it through what he called the Le Chatelier principle:

. . . while the change in an x with respect to its own parameters is always negative, regardless of the number of constraints, it is most negative when there are no constraints . . . 11/

The largest difference between these two studies is specific to the direct price flexibility coefficients for chicken. Filipello's appear very small and the current study's high.

11/ Samuelson, Foundations of Economic Analysis.

TABLE VI. DEMAND FLEXIBILITIES WITH COMPARISONS (COMPUTED AT MEAN VALUES).

	Filipello a/		Current Study	
	3-SLS	OLS	2-SLS	OLS
Direct Quantity:				
Beef	-.5994	-.6637	-.7130	-.5546
Pork	-.6772	-.7048	-.8355	-.5864
Chicken	-.0442	-.0412	-.9053	-.9026
Income:				
Beef	.7575	.8057	.8663	.7700
Pork	.6238	.6488	.2000	.2410
Chicken	.4569	.4132	.8257	.8986

a/ A. Filipello, "A Dynamic Econometric Investigation of the Japanese Livestock Economy" (unpublished Ph.D. Dissertation, University of Missouri, Columbia, 1968).

It is believed that Filipello's coefficient reflects certain statistical problems (e.g., multicollinearity), similar to the problem encountered in this study with respect to the pork demand and supply equations. Filipello's coefficient for this variable does not square with the estimates of the other meat products. For all meat commodities the results for the model in this study indicate that all prices are inflexible with respect to changes in quantity and income. Inflexibility of prices with respect to changes in quantity, other things held constant, would indicate a strong and growing demand for these commodities.

Since quantity supplied during most of the sample period has been increasing, it appears reasonable to assume that on the average, shifts in demand over time have reflected a stronger impact than the impact in the growth of supply. One can also assume that inflexible prices also suggest that supply could be increased substantially over time and consumption levels might increase without substantially decreasing market prices. The upward adjustment of consumption with small decreases in market prices could probably result more from the middle and low income groups expanding their consumption.

The effect of income on consumption indicates directly how consumers view a commodity. A more preferred or luxurious commodity will, in general, have a strong income effect. The fact that a higher income flexibility coefficient is obtained for beef than the other meats,

supports the hypothesis that beef is relatively preferred in the diet. Among the meat group, only the income flexibility coefficient of beef was higher than its price flexibility coefficient. Assuming equi-proportionate changes in quantity supplied and income, which counter each other, the residual effects would tend to influence increased price.

One of the more important variables for which there is no direct estimate is that of changes in tastes and preferences. Prosser has shown how the effects of changes in quantity consumed attributable to changes in tastes can be computed from observed data if the price and income elasticities of demand are known. ^{12/} A similar approach was applied in this study. The procedure was to partition the negative effect of quantity supplied and the positive effects of income and tastes on beef prices implicit in the beef demand function.

During the sample period the average annual increases in real beef prices, real income, and quantity of beef clearing the market were 5.2%, 9.0%, and 7.4%, respectively. ^{13/} To establish the net effect of prices on quantity supplied one takes the price elasticity of supply and multiplies it by the average increase in prices, i.e., for this study $[.106 \times 5.2\%] = .55\%$. This resulted in a $7.4\% - .55\% = 6.9\%$ average annual increase in quantity clearing the market, net of price effect.

^{12/} P. B. Prosser, "The Market for Beef in Japan," Quarterly Review of Agricultural Economics, XXVI, No. 2 (Canberra, Australia: 1973).

^{13/} Computed from Appendix Tables I, IV, and VI.

The computed income flexibility coefficient was .8663, implying that the rise in beef prices due to the income effect must equal $(.8663)(9\%) = 7.8\%$. But the increase in beef prices due to income is offset by the quantity effect on prices in the demand function. This measured effect was equal to the price flexibility coefficient times the increase in quantity clearing the market, net of the price effect or $(.703)(6.9\%) = 4.8\%$. Taking into account the income and quantity effect on prices, the average increase in beef prices would theoretically amount to $7.8\% - 4.8\% = 3.0\%$. But the actual observed beef price increase over time averaged 5.2%. The residual difference of 2.2% is then defined as an increase in price due to shift of tastes in the demand for beef in Japan.

It should be noted that any shift in the function is regarded as change in tastes. Thus defined, tastes in the framework of the Japanese demand for beef may include: (1) the economy's preferences and habits with respect to consumption; (2) patterns of income distribution; (3) the degrees of urbanization; and (4) stages of development of marketing, transportation, and processing of agricultural products, etc.

Cross price flexibilities were not obtained from the structural equations because of statistical specification. Likewise, the relationship of fish consumption to beef and the other meat items could not be directly related from the results of the structural equations.

But the reduced form inferred that the cross relationship of fish equilibrium prices to beef prices was quite strong. A marginal change in fish prices will induce a substantial change in beef prices. With respect to the quantity of chicken clearing the market, it suggests that chicken is also a strong substitute for beef.

The coefficient sign on current pork prices in the pork supply equation of the structural form suggested that producers react to their market expectations. If current prices increase and this increase is expected to hold through next year, producers could find it more profitable to hold back their stock from the market in order to benefit from rising future prices. If this is the case, then the coefficient of current prices of pork in the supply equation could reflect a negative relationship between price and quantity. The interpretations derived from the price flexibility and income flexibility coefficients in this study reflect, of course, relative potential changes. They do not necessarily reflect the future course of demand, since effective consumption for all meat products in the past has been very strongly determined by the levels of supply.

Projections

The real test of any theory is its ability to predict. Economic theory is generally formulated by theoreticians with no necessary responsibility for actual measurement or statistical verification

problems. The econometric task is to statistically estimate the theoretical parameters from real world observations and then to make predictions for non-observed situations. Thus, the prediction problem is a central issue in econometric analyses.

Prediction in econometrics must be viewed within the proper context. ^{14/} Measuring the values of variables outside the underlying sample observations is an act of extrapolation requiring more qualification as one moves further away from the sample period. Consequently, econometric prediction based on time series data must be considered within this context.

In general, the accuracy of time series projections (excluding specification errors or omissions in the theoretical framework) is conditioned upon the following:

- 1) The deviation of the estimated parameters from their true values.
- 2) The extent to which the assumption of no structural change between sample and prediction period is realized.
- 3) The deviation of assigned values of predetermined variables from their true values observed in future time periods.

^{14/} Klein distinguished between passive prediction versus active prediction, the first being identified with a prediction process where no structural change and changes in the parameter value is incorporated. (L. R. Klein, A Textbook of Econometrics (Evanston, Ill.: Evanston Publishing Co., 1953).)

- 4) The deviation of the true value of the disturbance from its expected value.

For purposes of checking the proposed model, some examination of how well it explains the past is examined. Predicted values of the endogenous variable with which primary interest is focused in this study is the price of beef (P_{bt}). Most of the remaining section will be concerned with the equation which involves this variable. The predictive value of (P_{bt}) based on the model's parameter estimates are compared and graphed against actual observed values for the same period. (See Figure 3.)

There are several computational procedures available to measure the accuracy of predictions. One is to calculate the standard error of prediction. This defines the distribution of predicted values and uses the root mean square error as a standard. ^{15/} Alternatively, another use is the Theil U statistic where the value varies between 0 and 1. ^{16/} The higher the overall predictive accuracy, the closer U is to zero. For purposes in this study, a simpler method will be employed. This involves the use of the graph in Figure 3 and computation of the average proportion of error for the sample period. The computed percentage of error was 5.9 per cent. Also, the acid test of

^{15/} Ibid.

^{16/} H. Theil, Economic Forecast and Policy (Amsterdam: North Holland Publishing Co., 1961).

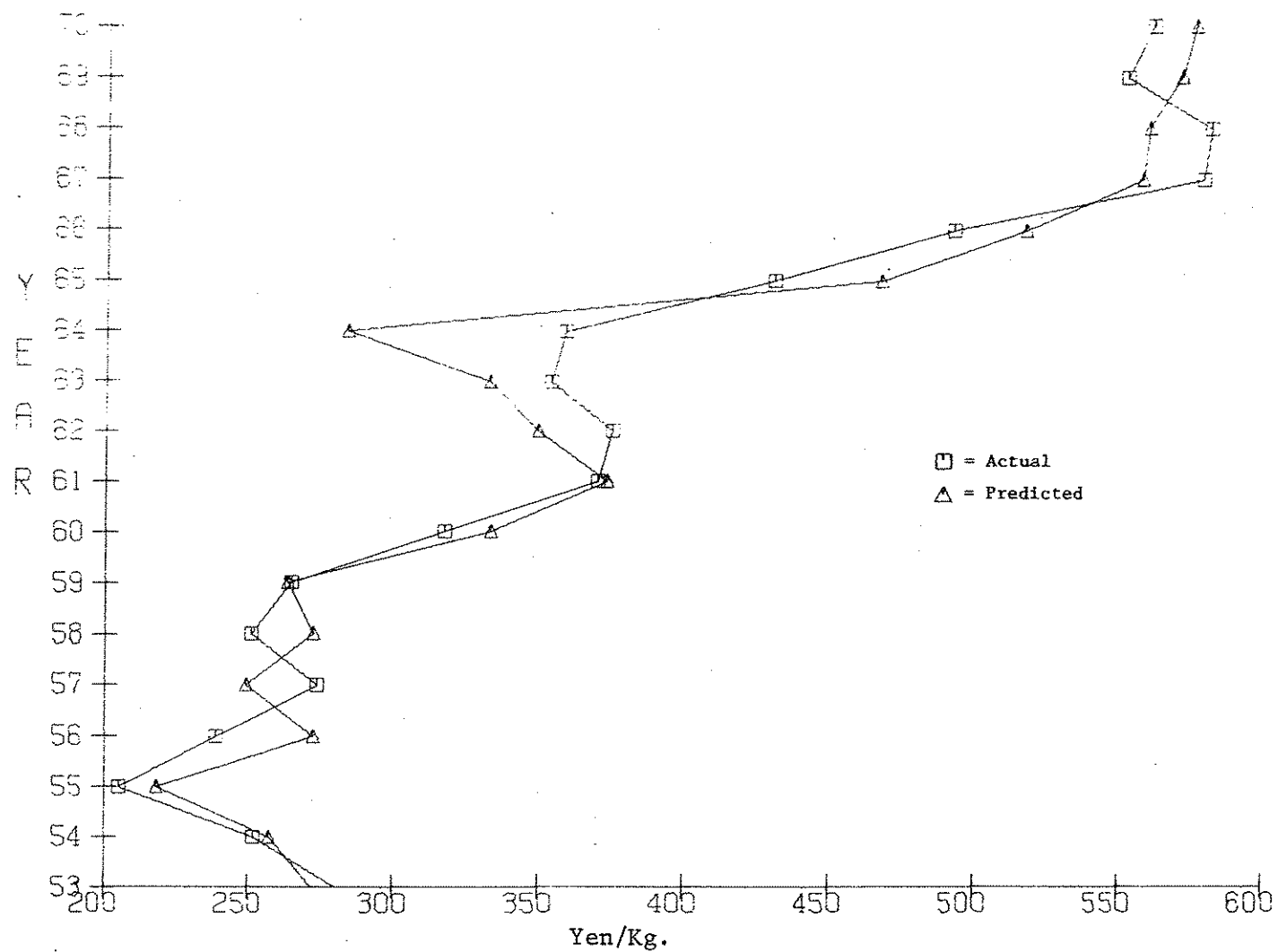


Figure 3. Japan: Actual and Predicted Values of Beef Wholesale Prices, 1953-1970.*

*Source: Computed from Appendix Table VIII.

the model's prediction was carried out using the reduced form for predicting beyond the sample period, but for recent periods in which the results are known. Actual observed data for 1971, 1972, and 1973, as listed in Appendix Table V, were substituted into the reduced form beef demand equation and the results obtained are summarized in Table VII. The wholesale prices of beef predicted in this manner were nominal wholesale prices. Since the structural form coefficients were transformed into the reduced form, all coefficients were deflated by the proper deflator at their mean values to preserve homogeneous scaling units.

The presence of an 11.8 per cent average prediction error indicates that the model may be relatively weak for taking into account substantial structural changes of demand for beef in Japan. By inspection one can see that the model predicts very well when compared with the 1971 and 1972 observed values having an average prediction error of 6 per cent. But the 1973 developments in the Japanese economy in general, and beef market in particular, deviate substantially from past trends, thus the model could not predict the magnitude which occurred. The beef price in Japan in 1973 was 64.4 per cent higher than the previous year.

One of the main objectives of this study was to assess or predict the effect of changes in the import quota policy variable as set by the Japanese Government on the price of beef (P_{bt}). These predictions

TABLE VII. JAPAN: ACTUAL AND PREDICTED VALUES FOR NON-SAMPLE OBSERVATIONS WHOLESAL PRICE OF BEEF 1971-1972 AND 1973 IN NOMINAL TERMS.

Japan	Index		Computed Weighted	Predicted	Error
Fiscal	1970 = 100 b/		Average c/		
Year a/	Domestic	Imported	Nominal	Nominal	
					Pct.
1971	103.2	111.8	693	756	+ 8.8
1972	112.8	128.3	767	796	+ 3.7
1973	171.7	222.4	1,261	973	-23.0
Total Error					35.5
Average Error					11.8

a/ Year ending March 31.

b/ Wholesale price of beef in 1970 = 664.0 Yen per Kilogram.

c/ Weighted by annual quantity produced domestically and annual quantity imported.

will be conditioned by factors mentioned above with the analysis restricted up to the year 1975.

There are two essential facets in establishing this prediction model. First, selection of realistic values of the import policy variable (Q_{bt}^M). Second, the need to obtain reasonable estimates of the future value of other exogenous variables. With respect to the former, a Food and Agriculture Organization study has estimated that the gap between domestic beef production in Japan and quantity demanded will be of the order of 170,000 metric tons in 1980. ^{17/} Prosser estimated this gap to be 300,000 metric tons by 1980. ^{18/} This estimate was developed by the difference between an 8.6 per cent average increase in quantity consumed associated with a 5.5 per cent increase in domestic beef production during the 1959-1971 time periods. A Japanese Government prediction for 1982 would place the beef production and consumption gap in 1980 between 300,000-400,000 metric tons. ^{19/} For 1973, the actual

^{17/} Food and Agriculture Organization, Agricultural Commodity Projections.

^{18/} Prosser, "The Market for Beef In Japan."

^{19/} The Japanese Government has projected a total meat import gap of 100,000 to 765,000 metric tons for 1982. As only small quantities of pork and poultry meats are likely to be required from overseas, the bulk of this would consist of beef. (Japan, Ministry of Agriculture and Forestry, Outline of the Projection for Production and Demand of Agricultural Products for 1982 (Provisional) (Tokyo: October, 1972).)

beef import data for Japan is published and was 127,224 metric tons. Others have predicted that domestic beef requirements will require Japan to increase imports of beef to 180,000 metric tons in 1974. 20/ For the purpose of this study, Prosser's figure in combination with the prediction of the Japanese Government that Japan will import +350,000 metric tons of beef in 1980 will be used.

An implied assumption in estimating Japan's future consumption and import policies rests on the presupposition of a satisfactory and quick resolution of the currently existing energy problem. If demand should weaken because of recession trends or if Japan's reserves should be drawn down quickly, the above estimated figure for future beef imports would likely fall.

Another aspect of the projection requires estimating changes over time of all other exogenous variables. Their future values were estimated using an autoregressive time trend. This procedure was preferred to simple non-autoregressive time trends because of data fit and more reasonable forecasts. The usual objection to using the autoregressive time trend relations is that they tend to compound errors. In this study, the intention is to predict only two time periods into the future, so that this problem is substantially reduced. It should be noted that the above method is a simple one, while the complexity of

20/ U. S. Department of Agriculture, Foreign Agricultural Service, Agricultural Attache Report.

the problem at hand calls for a more comprehensive method involving a more precise specification of each variable's functional relation. The extrapolative method was used mainly to demonstrate the mechanics of using the original system model for predictive purposes.

The reduced form demand equation is

$$P_{bt} = +382.678 + .0158Inc_t - .4649Q_{ch_t}^{DS} - 2.8278Q_{bt}^M + 4.3815P_{ft} \\ - 1.1379P_{bt-2} - 2.977Catt_{t-2} + 7.145P_{bar_{t-2}}.$$

Since primary interest is the reduced form beef demand equation, estimation will involve the following exogenous variables: income (Inc_t), wholesale price of fish (P_{ft}), and the quantity of chicken clearing the market ($Q_{ch_t}^{DS}$). The following relations were established:

$$Inc_t = 33.31 + 1.240Inc_{t-1} - .7509T$$

$$P_{ft} = -91.65 + .3872P_{ft-1} + 2.008T$$

$$Q_{ch_t}^{DS} = -1.851 + 1.040Q_{ch_{t-1}} + .03343T.$$

All the above relations seem to be sufficiently reliable for predicting the exogenous variables in a short-run framework.

With respect to the import policy variable (Q_{bt}^M), it was decided to use two different approaches to determine its value for 1974 and 1975. The first, as mentioned beforehand, was to increase the actual observed 1973 value by 30,000 metric tons annually to obtain forecasts for 1974

and 1975. The second was to base the 1974 value on a forecast recently made to obtain the 1975 value. 21/ This required increasing the 1974 estimate by 25,000 tons for the 1975 import estimate. Both approaches will bring Japan's quantity of beef imported to around 350,000 tons by 1980. Values estimated for the exogenous variables, including the policy variable, and the respective dependent variable predictions, are summarized in Tables VIII and IX.

The conditional predictions given in the above tables can be properly interpreted only by keeping in view several limitations. These can be summarized as:

- 1) The reliability of the prediction obtained is conditional on the validity of the assumption that the structure of the system and consequently the estimates of the parameters will not significantly change in the future. Expected changes in structure would need to be incorporated into the model before making predictions if structural changes were assumed relevant.

- 2) The predicted values were obtained on the basis of the assumptions that all future values of the disturbances in the estimated beef demand equation will equal their expected value of zero.

- 3) The reliability of predicted values of the exogenous variables.

21/ U. S. Department of Agriculture, Foreign Agricultural Service, Agricultural Attache Report.

TABLE VIII. COMPUTED ESTIMATES OF EXOGENOUS VARIABLES IN THE BEEF DEMAND EQUATION FOR 1974 AND 1975.^{a/}

Exogenous Variable	Estimated Value	
	1974	1975
Inc_t	116,340	144,239
P_{ft}	96.5	97
$Q_{ch_t}^{DS}$	752	784
P_{bt-2}	796	973
$P_{bar_{t-2}}$	69	105.9
$Catt_{t-2}$	1,789	1,759

^{a/} Computed from indexes from the following sources:

- 1) Bank of Japan, Wholesale Price Index Annual (Tokyo: Jan.-Dec. 1973).
- 2) Japan, Office of the Prime Minister, Japan Statistical Yearbook (Tokyo: 1973).
- 3) Economic Planning Agency, Japanese Economic Indicators, No. 262 (Tokyo: December 1973).

Income is total national income in billions of Yen, all prices are in Yen/Kg. and all quantities are in thousand metric tons.

TABLE IX. RESULTS OF PREDICTION ON WHOLESALE BEEF PRICES IN JAPAN FOR 1974 AND 1975 USING DIFFERENT FORECAST OF BEEF IMPORTS.

Forecast	Beef Imports		Actual Beef Wholesale Price 1973	Forecast Beef Wholesale Price	
	1974	1975		1974	1975
	---000 Met. T---		Kg.	-----Kg.-----	
I	155	185	1,261	935	1,357
II	180	205	1,261	864	1,300

In view of the above, there is always a necessity to account for prediction errors in judging prediction results. These include errors that originated from structural changes, future values of disturbances, and deviations between actual and predicted values of the exogenous variables.

Relation to the Beef Trade Flow of Australia

Most fresh, chilled or frozen beef that enters world trade originates in the temperate rangeland countries of the Southern Hemisphere and moves to the highly populated industrial countries of the Northern Hemisphere. As a rule, Oceania supplies the United States and Japan, while South American beef is shipped mainly to Western Europe. This pattern is partly a result of embargos established in the 1930's by the United States and Japan to control foot and mouth disease in cattle.

At present, the Japanese beef market share is determined among well-qualified exporting countries by virtue of their proximity to Japan, producing transportation cost advantages. There are primarily three countries--the United States, Australia, and New Zealand--currently involved in the export of beef to Japan. For agricultural farm products as a whole, the United States is still the largest exporter to Japan with an estimated value of \$1.6 billion in 1972 followed by Australia with almost \$1 billion. But in the beef sector, Australia is by far the largest supplier, exporting to Japan 52,712

tons of beef in 1972 as compared to 597 tons and 3,870 tons, respectively, for the United States and New Zealand. (See Table X.)

The Japanese Government being aware of their long-run dependency on certain agricultural products, has implemented a "develop imports" scheme in countries of the Far East and Oceania. This scheme actively promotes the production and trade of certain agricultural commodities, for example corn, sorghum, and beef. Implementation of this program involves aid, technical assistance, and direct overseas investments. As part of this "develop imports" program, Japanese firms have already started investments in the Australian beef industry.

For the purpose of this study, only the effect of the Japanese increased imports of beef on Australian beef trade flow will be discussed. This will also keep the problem in manageable proportion.

Traditionally, the United Kingdom had been Australia's major trading partner, but this has changed during the last five years. In anticipation of the United Kingdom's accession to the European Economic Community, Australia has been diversifying its trade away from the United Kingdom. Australia's preferential trade arrangements with the United Kingdom will cease with the entry of the U. K. into the European Economic Community. In 1971, Australia's exports to the United Kingdom was only 9 per cent of its total exports as compared to 39 per cent in 1950.

TABLE X. JAPAN: BEEF IMPORTS BY COUNTRY OF ORIGIN, 1972-1974.*

Year	United States	Southern Australia	New Zealand	Canada	Other	Total
-----000 Metric Tons-----						
1972	5.97	52.7	3.87	.012	.418	57.609
1973 <u>a/</u>	11.00	106.0	10.00	--	--	127.000
1974 <u>a/</u>	40.00	125.0	10.00	--	--	175.000

a/ Estimated.

*Source: Japan Meat Conference, "Meat Statistics in Japan" (Tokyo: May 1973).

As a concrete result of the diversification approach, Australia's exports to Japan rose from only 4 per cent in 1950 (14 per cent in 1960) to 20 per cent of its total in 1972 making it the largest foreign market for Australia's farm products. Exports to the United States went up from 8 per cent to 13 per cent during the same period.

Referring to Table XI, the United States continues to be Australia's largest market for beef in 1972 followed by Japan. But in the last two years, Japan has become the object of a beef trade triangle which includes Australia and the United States.

In 1973, the U. S. beef exports to Japan pulled ahead of New Zealand (see Table X) with an estimated export figure of 11,000 tons as compared to 10,000 tons from New Zealand. The forecast for 1974 indicates that United States exports of beef to Japan will reach 40,000 tons placing the United States as the second largest beef exporter for Japan.

Australia traditionally accounts for about 90 per cent of Japan's beef imports. These consist primarily of chilled or frozen low grade beef. However they ship nearly three times as much to the United States to augment United States supplies of manufacturing grade beef. Completing the triangle, the United States is increasing exports of higher priced, higher quality beef to Japan.

A recent development in Japan has been the widespread emerging preference for fresh, high quality table beef as opposed to manufacturing

TABLE XI. EXPORTS OF BEEF AND VEAL, BY COUNTRY OF DESTINATION: AUSTRALIA, 1950-1972 (THOUSAND TONS, PRODUCT WEIGHT).

YEAR	UNITED KINGDOM	EUROPEAN ECONOMIC COMMUNITY					UNITED STATES	CANADA	JAPAN	HONG KONG	SINGAPORE	MALAYSIA	PHILIPPINES	OTHER	TOTAL BEEF AND VEAL
		BELG-LUX.	FRANCE	ITALY	NETHERLANDS	GERMANY-FED. REP.									
1950-51	50.6	0.0 R	0.0 R	0.0 R	0.0 R	0.0 R	0.0 R	0.0 R	.1	3.8	4.7	.1 C	0.0 D	11.4	70.7
1951-52	22.4	0.0 R	0.0 R	0.0 R	0.0 R	0.0 R	0.0 R	0.0 R	.5	3.5	5.7	.2 C	0.0 D	10.5	42.8
1952-53	66.3	0.0 R	0.0 R	0.0 R	0.0 R	0.0 R	.9	0.0 P	.1	3.2	4.9	.2 C	.1	10.2	85.9
1953-54	121.1	.8	0.0 R	0.0 R	0.0 R	0.0 R	.5	0.0 P	.9	2.6	3.2	.1 C	.9	11.4	141.5
1954-55	98.1	1.4	0.0 R	0.0 R	0.0 R	0.0 R	.3	0.0 D	2.0	2.0	4.1	.4 C	2.4	11.8	122.5
1955-56	111.2	4.3	.2	1.6	.7	2.6	.8	0.0 D	1.0	1.8	4.5	.5 C	3.6	11.3	144.1
1956-57	115.4	2.8	.2	1.2	.2	.1	1.3	.1	7.2	4.1	5.0	.4 C	4.1	7.3	149.4
1957-58	96.6	3.0	0.0	.7	.2	0.0	5.0	.3	2.9	2.4	3.5	1.6 C	2.4	7.3	125.9
1958-59	153.0	1.8	0.0	.2	.4	.3	51.6	2.1	1.2	1.3	3.5	1.1 C	1.6	9.7	227.8
1959-60	81.6	2.4	0.0	.3	.1	.4	88.0	1.0	1.9	.9	2.6	1.5 C	1.1	6.4	186.2
1960-61	40.6	1.5	0.0	.1	0.0	0.0	76.7	1.0	3.0	1.1	2.7	1.2 C	.6	5.5	134.0
1961-62	35.5	.6	0.0	0.0	0.0	.1	146.8	2.9	3.7	1.4	2.8	.5 C	.8	6.1	201.2
1962-63	27.8	.2	0.0	0.0	0.0	.2	211.5	4.9	2.9	1.0	3.4	.6 C	1.1	7.2	260.8
1963-64	37.0	0.0	.6	2.5	0.0	.2	218.4	3.5	4.3	1.2	3.5	.4 C	1.2	8.5	281.3
1964-65	107.0	1.1	5.1	17.0	.9	5.1	141.7	1.8	5.9	1.1	3.6 H	0.0 I	1.2	24.5 E	316.0
1965-66	80.4	.3	1.2	5.9	.5	2.4	155.5	1.3	7.6	.6	1.9	1.1	1.0	13.8	273.5
1966-67	43.7	.1	.3	.9	.3	.2	185.3	3.4	7.5	.5	2.5	.5	1.0	11.9	258.1
1967-68	25.0	0.0 R	0.0 R	.2	0.0 R	0.0 R	196.9	3.8	12.0	4.6	2.2	.3	1.0	5.7	251.7
1968-69	13.8	0.0 R	0.0 R	0.0 R	0.0 R	0.0 R	201.5	8.8	14.7	.3	2.1	.5	.8	9.5	252.0
1969-70	26.7	0.0 R	0.0 R	.1	.1	.1	231.1	23.1	16.2	.2	2.0	.4	1.1	21.6 F	322.7
1970-71 A	30.8	.1	.1	.4	0.0 R	0.0 R	209.8	19.0	30.5	.5	2.5	.3	.6	41.4 G	336.0
1971-72 A	40.0	.1	.1	.2	.3	.3	255.2	18.8	47.2	.4	3.2	.5	.5	29.1 J	395.9

A. SUBJECT TO REVISION.
 B. INCLUDED, IF ANY, IN OTHER.
 C. MALAYA.
 D. LESS THAN 50 TONS.
 E. INCLUDES 8900 TONS TO GREECE AND 3100 TONS TO SWEDEN.
 F. INCLUDES 10900 TONS TO U.S.S.R.
 G. INCLUDES 28700 TONS TO U.S.S.R.
 H. INCLUDES MALAYSIA.
 I. INCLUDED WITH SINGAPORE.
 J. INCLUDES 11200 TONS TO U.S.S.R.

SOURCE: COMMONWEALTH BUREAU OF CENSUS AND STATISTICS, OVERSEAS TRADE (VARIOUS ISSUES).

quality frozen beef. This leads to the large increase in numbers of Wagyu heifers marketed. The very high quality Kobe and Matsuzaka beef, derived mainly from the best Wagyu heifers, is very highly priced and produced only in very small quantities. The top quality, highly marbled U. S. table beef closely resembles the Kobe and Matsuzaka beef.

This triangle relationship is made possible by the fact that Australia and U. S. beef exports into Japan cannot be classified as homogeneous commodities and consequently do not compete with each other in a direct sense. But the U. S. and Japan compete for the supplies of Australia's manufacturing quality beef, and this process will intensify over time with substantial increases forecasted in the Japanese beef import quota. ^{22/} Other markets for Australian beef are the United Kingdom, Canada, and the USSR, with 40.0 thousand tons, 18.0 thousand tons, and 11.2 thousand tons exported, respectively, for the calendar year 1971 (see Table XI). Total Australian exports for 1971 were 395.9 thousand metric tons, product weight.

In 1972, beef and veal production in Australia increased by 19 per cent as a response to buoyant world beef market demand and prices. The expansion in cattle numbers in recent years should enable the growth in

^{22/} U. S. Department of Agriculture, Economic Research Service, "The Agricultural Situation in the Far East and Oceania," ERS-Foreign 353 (Washington, D. C.: Government Printing Office).

beef output to continue in the near future in response to the expected continuation of high world demand. 23/

The complete beef trade flow for 1972 for Australia is not known but it is known that Australia exports 52,712 tons of beef to Japan and 330,000 tons of beef to the United States. 24/ With a calculated 19 per cent increase in production and exports, Japan and the U. S. together will control 82 per cent of Australia's total beef exports in 1972.

In 1973, Japan again increased its beef import quota from Australia to an estimated 106,000 tons, while the forecast for 1974 is 125,000 tons (see Table X). With this kind of pressure from Japan, expressed in terms of increased import prices, the U. S. seems also to be determined to capture its share of Australian beef supplies of about 350,000 tons. This is some indication to expect that Australia might abandon its other markets. 25/

Australian exports to Canada hinge on certain price differentials between the export price of Canadian feeder cattle to the U. S. and the

23/ Ibid.

24/ Ibid.

25/ Australian exports to the USSR declined by more than half in 1971 as compared to the 1970 figure. (Japan Meat Conference, "Meat Statistics in Japan.")

cost of substitute imports from Australia. 26/ Therefore, Canadian imports from Australia could be classified as having a re-export motive.

The price differentials are constantly declining reaching .19 Canadian dollars per head in 1969 as compared to 3.80 Canadian dollars per head in 1961. 27/ As a result, Canadian imports declined from 23,100 tons in 1969 to 18,000 tons in 1971.

With possible increased export prices from Australia due to the Japanese pressure, it might be reasonably expected that Australian exports to Canada will substantially decline.

In the United Kingdom market, it has been shown that as a result of their entry into the Economic Community, the Australian preferential trade agreement ceased to exist, while in terms of transportation cost, the United Kingdom has an obvious disadvantage.

If the hypothesis is accepted that due to Japanese pressure Australia is left with two main export markets, the U. S. and Japan, it could be anticipated that the terms of trade will be predominantly influenced by these two markets.

There are undoubtedly other economic factors, besides prices, which determine the annual amount of Australia's beef exports to any country. But perhaps looking at prices may provide some explanation

26/ U. S. Department of Agriculture, Economic Research Service, "Canada: Growth Potential of the Grain and Livestock Sectors," For. Agr. Econ. Rpt. 77 (Washington, D. C.: Government Printing Office, June 1972).

27/ Ibid.

of the important quantity variations pertaining to Australian exports to the U. S. and Japan. Overall, it could be useful in obtaining some rough indication of the expected change in the Australian beef trade flow.

Table XII contains average annual export prices of Australian beef to Japan and the U. S. on a c.i.f. basis. These price series are not exactly comparable due to differences in method of computation while pertaining to slightly different beef grades. The Japanese price series were obtained by dividing total export value in Yen by total product weight while the U. S. price series was based on monthly quotations.

Most Australian beef exported to Japan has been frozen cuts and sides, although chilled beef is now becoming increasingly important. Australian exports to the U. S. are predominantly boneless bull and cow manufacturing grade beef. The Japanese price series shows an increasing trend which resembles the trend of their domestic wholesale prices. This is also applicable to the U. S. price series.

Both countries have been capturing a larger portion of Australian exports over time, except for the decline noted for the U. S. in 1970. Increasing demand trends in both countries seems to indicate that the competition for Australian beef supply will intensify over time.

It also appears that price changes and the proportion of Australian beef shipped to either Japan or the U. S. will depend on the Australian rate of growth of beef production. The outlook for U. S. beef demand

TABLE XII. AVERAGE ANNUAL EXPORT PRICES AND QUANTITY SHIPPED OF AUSTRALIAN BEEF PRODUCTS TO JAPAN AND THE U. S., 1964-1972.*

Year	Japan			United States		
	Quantity		Average	Quantity		Average
	as Proportion		Annual	as Proportion		Annual
	in 1,000	of Australia's	Export	in 1,000	of Australia's	Export
	Tons a/	Annual Export	Prices b/	Tons	Annual Export	Prices c/
			<u>US\$/Kg.</u>			<u>US\$/Kg.</u>
1964	5.9	.019	.59	141.7	.45	.83
1965	7.6	.028	.64	155.5	.57	.86
1966	7.5	.029	.78	185.3	.72	1.00
1967	12.0	.048	.98	196.9	.78	1.02
1968	14.7	.058	.97	201.5	.799	1.05
1969	16.2	.050	.84	231.1	.72	1.18
1970	30.5	.090	.96	209.8	.62	1.26
1971	47.2	.120	1.12	255.0	.65	1.29
1972 <u>d/</u>	57.6	.123	1.38	330.0	.70	1.55

a/ In tons product weight (the Japanese statistics quote it in terms of carcass weight equivalent).

b/ Implicit price obtained through dividing total value by quantity quoted in Yen but converted into U. S. dollars. Conversion rate, 1964-1970, US\$ = 360 Yen; 1971, US\$ = 347.17 Yen; 1972, US\$ = 308 Yen.

c/ Quoted originally in pounds, but converted to kilograms. Kg = 2.2046 pounds.

d/ Estimates.

*Source: Bureau of Agricultural Economics, Statistical Handbook of the Meat Industry (Canberra, Australia: 1973).

TABLE XIII. AUSTRALIA: PRODUCTION AND EXPORTS OF BEEF AND VEAL.*

Year	Production in Carcass Weight	Exports in Carcass Weight	Exports in Product Weight
-----000 Metric Tons-----			
1964	1010.1	457.3	316.0
1965	931.4	412.0	273.0
1966	864.7	383.8	258.0
1967	889.6	380.8	251.0
1968	920.0	379.7	252.0
1969	944.5	481.0	322.0
1970	1030.7	491.1	336.0
1971	1145.6	587.5	395.0
1972 <u>a/</u>	1363.2	709.1	470.0

a/ Estimates based on 19 per cent increase in beef production.

*Source: Bureau of Agricultural Economics, Statistical Handbook of the Meat Industry (Canberra, Australia: 1973).

requirements in 1973 and 1974 indicated that U. S. imports from Australia are expected to remain at the current high levels, but will be dependent on import requirements for meat. 28/

With Japan's beef import requirement for 1973 and 1974 forecasted at 106,000 tons and 125,000 tons, respectively, and the U. S. sustaining its 350,000 ton range (330,000 tons in 1972), Australian export prices could move to higher equilibrium levels. Their beef trade flow pattern will probably change gradually concentrating more on the U. S. and Japanese markets.

Higher equilibrium quantities are also expected to move through these export channels. There appears to be no significant domestic constraints present in Australia's effort to significantly increase its export supplies relative to the ever increasing foreign demand for beef products.

28/ U. S. Department of Agriculture, Economic Research Service, "The Agricultural Situation in the Far East and Oceania."

CHAPTER VII

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS FOR FUTURE RESEARCH

One of the major objectives of this study was to derive a demand equation for beef in Japan and to compute and interpret its structural parameters. Some information then was provided on the expected magnitude of the response of beef wholesale prices to specified changes in import quotas. In addition since these future beef prices are related to equilibirums existing in the international market for beef, some analysis of the international impact was included.

Time series data covering the period 1953-1970 were used in the estimation procedure while additional 1971-1973 data were used to assess the predictive power of the model. The econometric model investigated consisted of five behavioral relations. Although the major interest was to be concentrated on the demand for beef in Japan, other relations had to be incorporated because of the interrelated nature of the economic system. One of the main purposes of this investigation was to attempt to refine the current knowledge relative to the demand elasticity for meat products in Japan with special emphasis on beef. An attempt was also made to forecast potential changes in beef wholesale prices. The demand functions for beef in the structural form provided the informational/analytical framework for further analyses, while the reduced form provided the basis for forecasting. The model was specified in a simultaneous equation system

with Two-Stage Least Squares being used as the statistical method for estimating the structural parameters.

The simultaneous structure was adopted and specified because knowledge of Japanese consumption patterns indicates a substitution relationship among the meat groups. Consumer decisions related to beef consumption is interdependent with decisions related to consumption of other primary meats. Also, fish occupy an important place as a human food protein source in Japan but it was not possible to get reliable estimates of the interaction of the beef-fish relation from the data base.

The structural coefficients were estimated without a priori restrictions as to sign or magnitude. Price, quantity, and income variables in all demand equations were deflated while price and quantity variables in the supply equation were not deflated. This procedure requires applying the proper correction on the structural coefficients when making the transformations into the reduced form. The major reason being to obtain an identical scale for variables in their respective demand and supply equations. The mean values of population, wholesale, and consumer price indexes were used in this process. The wholesale market was the level used in the analysis. Among the reasons for this were that this market level would reflect the greatest measurable price response to imports.

The results indicate that over time the quantities demand of beef in Japan can be expected to become much stronger. This is primarily a result of Japan's growing affluence and an indicator of shifting tastes. Shift in tastes appear to have occurred in Japan. Some of the reasons pointed out by other researchers include, the high rate of economic development, social change, change in dietary habits, and urbanization, accompanied by rapid acculturation in the direction of modern (Western) culture. Most other research efforts have not made an attempt to isolate the magnitude of this change. The attempt to do this in this study will hopefully add to the knowledge in a quantitative way. The changing taste and dietary habits occurring in Japan at present seem to favor primary meats, but the results of this study also show that consumer attitudes have indicated a strong preference for beef. Japan's increase in population is certainly another important determinant of market growth for beef. With a recorded average of 1 per cent annual population growth, the population effect must be significant with respect to total aggregate beef consumption.

It is concluded that beef prices will follow an increasing trend in Japan. Contributing factors to this upward trend in beef prices would include a generally inadequate supply, increased income levels, and the capability for substitution of fish and vegetables for the beef product. The leveling off of total fish consumption is primarily caused by inadequate supply. Although pollution has scared off

consumption of fish, the increasing trend of fish supply prices indicate no future relative price advantage developing for fish products. Rich fishing areas--such as Tokyo Bay, Osaka Bay, and Hiroshima Bay--are now becoming "dead" polluted waters. The inland sea may soon be in the same condition. It is believed that increased pollution and the necessity to haul fish from distant oceans will significantly increase the supply price for fish.

A detailed look at changes in the animal protein component of the Japanese diet indicates that in 1971, for the first time, livestock and poultry products surpassed fish consumption. This was an astonishing gain of 250 per cent in quantity consumed since 1964. Within this group meat consumption increased most sharply of all categories. Shifts away from vegetable protein sources could also be mentioned as contributing to the increase in the demand for beef. The use of protein, both animal and vegetable, has increased by 12 per cent between 1964 and 1971. Of this, however, animal protein consumption soared by 54 per cent, while vegetable protein use declined by 7 per cent. In conclusion, Japan's potential for growth in beef consumption is enormous, if not inhibited by customs regulations. Large short-term growth rates in consumption are slowed by the impact of high prevailing price levels which are related to import policies.

If demand for beef strengthens as the potential in this study indicates, Japan can be expected to adopt policies which will lead to

the augmentation of available beef supply. The only realistic alternative for significantly increasing this supply would appear to rest with expanded imports. For the last two years, the Japanese Government has been under considerable pressure to meet increasing consumer demand for beef. This condition is confirmed by the substantial increase in beef imports in 1973 which are 127,000 or almost twice the amount imported in 1972. On the other hand, Japan also indicates some signs of being determined to protect its domestic producers. The major effect is simply to reduce the quota if prices drop below a level which is considered too low for domestic producers to compete. Therefore, it seems that for the future the Japanese Government will have to employ the quota system with respect to beef imports if the domestic market prices of the past are considered a necessity for domestic agricultural price policy. There is very little certainty about any forecasted future magnitude of beef imports into Japan since these are basically internal policy issues.

The results indicate that the annual amount of beef imports, is at this moment, the only variable on the supply side which can be significantly changed and which has the potential to substantially affect price. Results in this study indicate that within the expected bound of imports, based on existing information, beef wholesale prices will experience a relatively small decrease in 1974, but will increase a substantial amount in 1975. This future price movement reflects increasing shifts

in demand that will outweigh the effects of government control on supply by increased imports.

With respect to the international market, the continuing increases in demand for beef in Japan will have significant impact on Australia's beef export prices and its trade flow. This is especially true if Japan continues its present import policy of non-diversified overseas supply sources for beef. Ignoring stringent bilateral trade agreements of the type which were in effect before the 1970's, all evidence gathered in this study points to an increased role of Australia in the Japanese and the U. S. beef markets. With demand for Australian beef in the U. S. expected to stay at least at the 1973 level, and it could well increase substantially, much of the future price levels in beef will be a function of the ability of the Australians to expand output. There seems to be an ability to do just this as indicated by the large expansion in cattle numbers in Australia during the last few years. Feed grain availability appears sufficient at slightly higher prices. This would curtail feed grain export earnings in favor of beef. Interaction of demand for and supply of Australian beef exports will most likely result in increased export prices.

Limitations of the Study

In the text, where appropriate, expected limitations of this study either from the point of view of economic theory or statistical concepts have been discussed. A few, however, will be added and reviewed.

The limited availability of alternative data sources for use in supporting certain evidence presents some uneasy feelings toward drawing strong conclusions. Fortunately, this does not involve the data used as a direct input in the model.

From the methodological point of view, the non-quantitative procedures used to arrive at conclusions with respect to the relationship of the Japanese demand for beef and the international movement of beef products is unsatisfactory. Consideration should be given to the use of more reliable tools of analysis. 1/

The inability to incorporate fish consumption in the model precludes more refined analysis of the demand for beef since fish is an important protein source item in the Japanese diet. Likewise, the absence of cross-effects analysis inhibits the full disclosure of the inter-meat group relationship.

The consideration of only three commodities in the meat group weakens the conclusions. For instance, Japan's import of mutton and lamb at a level of 151,000 tons in 1972, almost 2.5 times its beef imports for the same year, could appreciably affect beef imports and consumption.

1/ Samuelson's model of spatial price equilibrium adapted by L. D. Bawden for handling tariff and import quota restrictions.

Recommendations for Future Studies

Future research on international trade and the demand and supply of beef appears to be a fruitful field for meaningful and valuable results. Specifically, on the demand side, detailed studies on other beef importing countries, such as the European Economic Community, with or without the United Kingdom, could lay the groundwork for more accurate world beef demand projections. These could be tied with studies of the United States demand for beef.

Beef is a commodity that on the average appears to have a rising price trend (due to demand increases) on world markets, at least up to around 1980. Therefore, it should be equally important to direct future studies so as to explore the potentials of new supply sources.

Within the meat group, future research should adopt the commodity approach instead of the commodity group approach. With respect to Japan, detailed information on the supply side will make demand studies more effective in terms of interpretation and empirical context. Also, pork and poultry products deserve future research attention due to the fact that per capita pork and poultry consumption is twice and three times that of per capita beef consumption, respectively, at present in Japan.

APPENDIX

APPENDIX TABLE I. TOTAL AVAILABILITY OF SUPPLY OF BEEF, 1953-1970*

Japanese Fiscal Year a/	Domestic Production	Imports	Total Available Supply
-----Thous. Metric Tons-----			
1953	84	--	84
1954	92	1	93
1955	135	1	136
1956	134	5	139
1957	117	23	140
1958	132	3	135
1959	150	3	135
1960	141	6	147
1961	141	6	147
1962	153	4	157
1963	199	5	204
1964	228	6	234
1965	190	11	221
1966	152	14	168
1967	148	16	164
1968	172	15	187
1969	230	18	248
1970	265	33	298

a/ Year ending March 31.

*Source: Japan, Ministry of Agriculture and Forestry, Statistical Yearbook (Tokyo: 1953-1971).

APPENDIX TABLE II. JAPAN: TOTAL AVAILABILITY OF SUPPLY OF PORK,
1953-1970*

Japanese Fiscal Year a/	Domestic Production	Imports	Total Available Supply
-----Thous. Metric Tons-----			
1953	88	--	88
1954	77	--	77
1955	86	--	86
1956	116	--	116
1957	142	--	142
1958	170	--	170
1959	177	1	178
1960	150	6	156
1961	241	1	242
1962	322	--	322
1963	273	8	281
1964	314	2	316
1965	386	--	386
1966	542	--	542
1967	546	--	546
1968	511	18	529
1969	525	36	561
1970	691	17	708

a/ Year ending March 31.

*Source: Japan, Ministry of Agriculture and Forestry, Statistical Yearbook (Tokyo: 1953-1971).

APPENDIX TABLE III. JAPAN: TOTAL AVAILABILITY OF SUPPLY OF CHICKEN, 1953-1970*

Japanese Fiscal Year a/	Domestic Production	Import	Total Available Supply
-----Thous. Metric Tons-----			
1953	19	--	19
1954	31	--	31
1955	33	--	33
1956	35	--	35
1957	38	--	38
1958	41	--	41
1959	41	--	41
1960	44	--	44
1961	57	--	57
1962	121	--	121
1963	142	5	147
1964	181	4	185
1965	205	8	213
1966	261	7	267
1967	303	10	313
1968	336	18	354
1969	423	20	443
1970	505	12	517

a/ Year ending March 31.

*Source: Japan, Ministry of Agriculture and Forestry, Statistical Yearbook (Tokyo: 1953-1971).

APPENDIX TABLE IV. JAPAN: NOMINAL ANNUAL AVERAGE WHOLESALE PRICES*a/

Japanese Fiscal Year b/	Beef	Pork	Chicken	Fish	Barley
	-----Yen/Kg.-----				
1953	233.0	253.0	194.0	31.5	52.8
1954	226.0	301.0	194.0	31.0	52.7
1955	181.0	278.0	187.0	34.9	52.4
1956	206.0	247.0	214.0	44.0	52.0
1957	243.0	263.0	215.0	43.0	51.5
1958	221.0	235.0	200.0	39.0	50.5
1959	235.0	264.0	220.0	38.0	50.0
1960	287.0	345.0	228.0	45.0	49.6
1961	337.0	300.0	331.0	47.0	48.4
1962	342.0	278.0	248.0	45.0	48.3
1963	345.0	389.0	247.0	53.0	49.6
1964	349.0	373.0	228.0	64.4	53.3
1965	431.0	374.0	253.0	74.8	53.3
1966	511.0	326.0	243.0	69.0	57.2
1967	610.0	362.0	243.0	68.0	57.6
1968	645.0	438.0	248.0	62.0	58.6
1969	641.0	481.0	235.0	73.0	62.6
1970	667.0	398.0	235.0	74.0	68.1

a/ One US dollar = 360 Yen.

b/ Year ending March 31.

*Sources: Japan, Ministry of Agriculture and Forestry, Statistical Yearbook (Tokyo: 1953-1971) and arithmetic average of wholesale prices in major cities.

APPENDIX TABLE V. JAPAN: ACTUAL VALUES OF EXOGENOUS VARIABLES USED TO TEST THE REDUCED FORM BEEF DEMAND FUNCTION AGAINST NON-SAMPLE DATA, 1971-1973.* a/

Exogenous Variable	1970 Observa- tion	Index			Computed Actual Values			Units
		1971	1972	1973	1971	1972	1973	
Inc_t = Total national income <u>b/</u>					64,176	73,301	93,841	Bil. Yen
Q_{bt}^M = Annual quantity of beef imported <u>b/</u>					41.572	57.609	126	1000 Metric Tons
$Q_{ch_t}^{DS}$ = Quantity of chicken clearing the market <u>b/</u>					566	650	723	do.
P_{ft} = Wholesale price of fish	74.0	114.0	112.0	137.6	84.0	83.25	102.0	Kg.
P_{bt-2} = Wholesale price of beef in time t-2 <u>b/</u>					641	664.6	693	Kg.
$P_{bar_{t-2}}$ = Wholesale price of barley in time t-2 <u>b/</u>					66.2	68.1	71.0	Kg.
$Catt_{t-2}$ = Cattle inventory in time t-2					1,695	1,789	1,759	1000 Head

a/ Sample data used in deriving the demand function for beef cover the period 1953-70.

b/ Actual observations.

*Source: Japan, Ministry of Agriculture and Forestry, Statistical Yearbook (Tokyo: various issues). (Note: All prices and income in nominal terms and all quantities in aggregate terms.)

APPENDIX TABLE VI. JAPAN: MACRO-ECONOMIC DATA, 1953-1970.

Japan Fiscal Year a/	National Income b/	Population	Consumer Price Index 1965 = 1.00 c/	Wholesale Price Index 1965 = 1.00 c/
	<u>Bils. of Yen</u>	<u>000</u>		
1953	5.747.7	86,981	.646	.83
1954	6.022.4	88,239	.681	.898
1955	7.298.5	89,227	.671	.882
1956	8.173.4	90,126	.677	.863
1957	9.354.7	90,895	.697	.888
1958	9.616.1	91,733	.704	.882
1959	11.023.3	92,603	.714	.886
1960	13.269.1	93,389	.74	.904
1961	15.755.1	94,244	.779	.911
1962	17.279.8	95,136	.83	.913
1963	20.614.5	96,111	.896	.975
1964	23.375.1	97,128	.933	.966
1965	26.086.8	98,208	1.00	1.00
1966	30.442.7	99,042	1.05	1.036
1967	36.233.2	100,166	1.093	1.054
1968	42.869.6	101,343	1.151	1.109
1969	49.856.7	102,520	1.211	1.16
1970	49.048.0	103,720	1.304	1.184

a/ Year ending March 31.

b/ Japan, Bureau of Statistics, Office of the Prime Minister, Japan Statistical Yearbook (Tokyo: 1964), pp. 492-493; (1971), pp. 11, 350, 489.

c/ Japan, Ministry of Agriculture and Forestry, Statistical Yearbook (Tokyo: 1953-1970).

APPENDIX TABLE VII. AUSTRALIA: PRODUCTION AND EXPORTS OF BEEF AND VEAL.*

Year	Production in Carcass Weight	Exports in Carcass Weight	Exports in Product Weight
-----000 Metric Tons-----			
1964	1010.1	457.3	316.0
1965	931.4	412.0	273.0
1966	864.7	383.8	258.0
1967	889.6	380.8	251.0
1968	920.0	379.7	252.0
1969	994.5	481.0	322.0
1970	1030.7	491.1	336.0
1971	1145.6	587.5	395.0
1972 a/	1363.2	709.1	471.0

a/ Estimates based on 19 per cent increase in beef production.

*Source: Bureau of Agricultural Economics, Statistical Handbook of the Meat Industry (Canberra, Australia: 1973).

APPENDIX TABLE VIII. 2-SLS OF DEMAND FOR BEEF IN JAPAN, 1953-1970
(ACTUAL AND PREDICTED VALUES).

Actuals	Predicted	Residuals	Pct. Error
280.000	271.887	8.113	2.898
252.000	257.247	- 5.247	- 2.082
205.000	218.140	-13.140	- 6.410
239.000	272.824	-33.824	-14.152
274.000	249.182	24.818	9.058
251.000	272.719	-21.719	- 8.653
265.000	263.473	1.527	0.576
317.400	333.430	-16.030	- 5.050
370.000	373.337	- 3.337	- 0.902
375.000	349.541	25.459	6.789
354.000	333.045	20.955	5.920
359.000	293.825	65.175	18.155
431.000	467.656	-36.656	- 8.505
493.000	517.724	-24.724	- 5.015
579.000	558.065	20.935	3.616
582.000	560.464	21.536	3.700
552.600	571.458	-18.858	- 3.413
561.400	576.385	-14.985	- 2.669

Ave. Error = 5.9%

$$\begin{aligned}
 A &= \begin{bmatrix} 1 & 141.2 & 0 & 0 & 0 \\ .04634 & 1 & 0 & 0 & 0 \\ .9339 & 0 & 1 & 92.77 & 0 \\ 0 & 0 & 1.074 & 1 & 0 \\ .3808 & 0 & 0 & 0 & 1 \end{bmatrix}, Y_t = \begin{bmatrix} P_{bt} \\ P_{bt} \\ Q_{bt} \\ P_{pt} \\ P_{pt} \\ Q_{pt} \\ P_{cht} \end{bmatrix} \\
 B &= \begin{bmatrix} 147.6 & 1.1462 & -48.91 & -297.5 & 4.673 & 0 & 0 & 0 & 0 & 0 \\ -356.3 & 0 & 0 & 0 & 0 & .8476 & .2218 & -5.332 & 0 & 0 \\ 41.77 & .3368 & 0 & 0 & 2.89 & 0 & 0 & 0 & 0 & 0 \\ 301.4 & 0 & 0 & 0 & 0 & 0 & 0 & -7.155 & 1.219 & 1.4 \\ 50.81 & .8989 & -134.4 & 0 & 1.264 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}, X_t = \begin{bmatrix} 1 \\ Inc_t \\ S_{ch} \\ Q_{bt}^M \\ P_{ft} \\ P_{bt-2} \\ Catt_{t-2} \\ P_{bar_{t-2}} \\ P_{pt-2} \\ P_{pt-2} \end{bmatrix} \\
 U_t &= \begin{bmatrix} U_{1t} \\ U_{2t} \\ U_{3t} \\ U_{4t} \\ U_{5t} \end{bmatrix}
 \end{aligned}$$

Appendix Figure 1. Structural Coefficients.

$$\begin{array}{c} Y_t \\ \left[\begin{array}{c} P_{bt} \\ Q_{bt}^P \\ P_{pt} \\ Q_{pt}^P \\ P_{cht} \end{array} \right] \end{array} = \begin{array}{c} \pi \\ \left[\begin{array}{cccccccccc} 382.698 & .0158 & -.4649 & -2.8278 & 4.3815 & -1.1379 & -.2977 & 7.145 & 0 & 0 \\ -327.955 & .0007 & -.0215 & -.131 & .203 & .795 & .2080 & -5.0003 & 0 & 0 \\ -33299.9 & -1.8998 & 44.0726 & 268.067 & -708.749 & 107.872 & 28.228 & -1361.62 & 116.368 & 133.646 \\ 36065.2 & 2.0403 & -47.334 & -287.904 & 761.153 & -115.855 & -30.3168 & 1455.22 & -123.76 & -142.136 \\ 281.843 & .01642 & -1.5433 & 1.077 & 2.9319 & -.4332 & -.1133 & 2.7254 & 0 & 0 \end{array} \right] \end{array} \begin{array}{c} X_t \\ \left[\begin{array}{c} 7 \\ Inc_t \\ Q_{cht}^{DS} \\ Q_{bt}^M \\ P_{ft} \\ P_{bt-2} \\ Catt_{t-2} \\ P_{bar_{t-2}}^P \\ Q_{pt-2}^P \\ P_{pt-2} \end{array} \right] \end{array}$$

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Appendix Figure 2. Reduced Form Coefficients.

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