

JAPAN'S IMPORTED BEEF MARKET: A CHARACTERIZATION  
OF LOYALTY TOWARD INDIVIDUAL SUPPLIERS AND  
ASSESSMENT OF COMPETITION AMONG SUPPLIERS

by

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B.S., Kansas State University, 1983

M.S., Kansas State University, 1985

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A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Agricultural Economics

KANSAS STATE UNIVERSITY  
Manhattan, Kansas

1987

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## INTRODUCTION

Problem Statement. Japan is a major importer of beef. In 1985, the Japanese imported over 146,000 metric tons of beef. The Japanese beef market is of particular interest to the United States beef exporters, because 65 percent of all United States beef exports have gone to Japan in recent years. In view of the importance of the Japanese beef market, the degree of competition which exists among exporters in that market is a concern to any nation currently exporting beef to Japan, and to nations planning to export to Japan in the future. The degree of competition in that market will influence trade policy formation in the U.S. and other exporting countries, because trade policies must be formulated with as much knowledge about market structure as possible. Private beef exporting organizations in the U.S. could also benefit from a better understanding of the competitiveness of the Japanese beef market. Information about the competitive position of the U.S. relative to other exporting nations will help private exporters determine how resources devoted to promotion and product development can be most efficiently used. To date, however, little information concerning the overall competitiveness of the Japanese beef market can be found in the literature.

Purpose and Rationale. The objective of this study is to determine Japanese market loyalty toward its individual beef suppliers (exporting countries). Estimated transition probabilities are used to measure that market loyalty. Information needed to assess the degree of

competitiveness that exists among exporters in the Japanese beef market is provided in the transition probabilities, because buyer loyalty influences market competitiveness. Additionally, per unit beef prices paid to exporting nations are compared between exporters. This comparison determines if beef from all exporters is considered homogeneous, or if the beef from certain exporters is viewed by the Japanese as distinct from beef imported from other suppliers.

A product market with a high degree of homogeneity and substitutability among the products of all suppliers will likely be more competitive than a market dominated by dissimilar products that are poor substitutes for each other. When the imported products from two suppliers are good substitutes, a rational importer would pay approximately the same price to both exporters. If the prices paid to two exporters are found to be statistically different, the importer does not consider the two products to be good substitutes. When products in a market do not substitute well for one another, competition is reduced.

It is useful to characterize the degree of homogeneity and substitutability that exists in the Japanese beef import market among beef of different supplier origin through a comparison of beef prices. The author's hypothesis is that the Japanese view beef imported from the U.S. as distinct from beef imported from Australia, New Zealand and the rest of the world. This hypothesis follows from the fact that U.S. beef is highly marbled, "fed" beef compared to beef from Australia and New Zealand which has little marbling and is often referred to as "nonfed" beef.

Importer buying behavior reflects product relationships in that strong loyalty toward a particular supplier may indicate that a suitable substitute is unavailable in the marketplace. Further, importer buying behavior with regard to loyalty toward individual suppliers will influence competitiveness in the marketplace, because such behavior includes the manifestations of institutional and political relationships as they exert pressure on the market. Competition in the market is reduced when institutional and political relationships cause an importing nation to favor one supplier over another though the exported products from the two suppliers are homogeneous.

Theil and Rey (1966), Dent (1967) and Wilson et al. (1986) used buyer transition probabilities to describe buyer behavior. Transition probabilities reflect a buyers propensity to switch from one supplier to another. In the context of international trade, transition probabilities measure the likelihood that an importing nation, currently buying from a certain exporting country, will switch to a different supplier in the next time period.

Transition probabilities are a function of relative prices, product quality and promotion (Telser, 1962). Estimation and analysis of transition probabilities for an importing country is, thus, a useful means of characterizing that country's buying behavior, particularly regarding importer loyalty toward individual suppliers. In the Japanese imported beef market, estimation of transition probabilities as a description of Japanese beef buying behavior is helpful as a first step toward understanding the degree of overall competitiveness of the market.

Market Environment. Japan's rise to becoming an important participant in world beef trade has its roots in the rapid growth of Japanese per capita meat consumption and in the country's geography and size. There is little doubt that by the mid-1950s the Japanese people were a meat hungry population (Longworth, 1984). After 1955, mechanization of rice production reduced the need for draft animals, and large numbers of cattle were diverted to beef production. Per capita incomes were also increasing rapidly, and the Japanese people found that they could afford to purchase meat more often. The upward trend in per capita meat consumption was especially apparent during the income-doubling decades of the 1960s and 1970s.

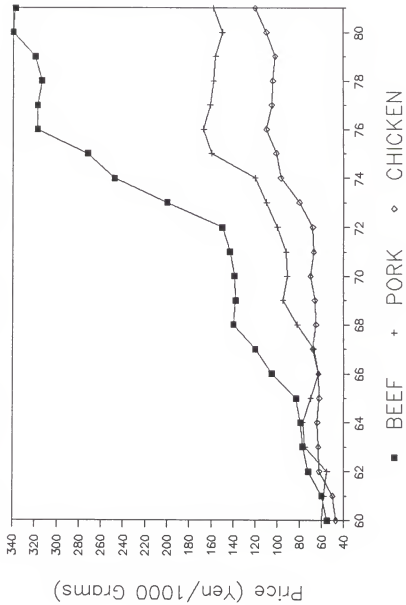
Beginning in the late-1950s, consumption for beef outpaced domestic beef production and beef imports increased. Limited pasture and forage area constrained beef production in Japan, which comes primarily from Wagyu (indigenous Japanese beef cattle), fattened dairy steers and cull dairy cows. Australia has been Japan's primary beef supplier. However, in recent years, the U.S. has substantially increased its share of Japanese beef imports. New Zealand held a large share of the Japanese beef import market in the early 1960s, but by 1983, that country held only a small fraction of the market.

Beef importation in Japan is a highly regulated activity. Substantial political support for the maintenance of agricultural producer incomes and concern for food security have resulted in a combination of regulations which have undoubtedly limited Japanese beef imports. Import quotas, tariffs and import surcharges have protected domestic livestock producers and led to rising retail beef prices that

have increased at a faster rate than prices for either pork or chicken. (Figure N1).

Thesis Method. An application of a finite, first order Markov process is used in this study to develop transition probabilities for exporting countries' market shares of Japanese beef imports. The transition probabilities are estimated using an inequality-restricted estimation based on the Minos quadratic programming algorithm. transition probabilities are developed for the periods 1960 to 1985 and 1975 to 1985. A comparison of the transition probabilities from the two periods is used to determine whether Japanese supplier loyalty and the competitive position Japan's primary beef suppliers changed in the past decade. Per unit beef prices are also compared between Japanese supplier countries using a paired t-test. The results are presented and discussed with special emphasis placed on how the resulting transition probabilities and per unit price differences (or lack thereof) among beef suppliers influence the overall competitiveness of the Japanese beef market.

Figure N1: Average Annual Prices for Major Meats in Japan (1960 to 1981).





## JAPAN'S BEEF IMPORT SYSTEM

Beef trade flows between Japan and the United States are influenced by political, social and economic issues. Liberalization of beef trade and protection of Japan's livestock industry are considered two conflicting policy goals. Severe restrictions have been imposed on the imports of beef into Japan, resulting in substantial social costs. This restriction is especially severe since the efficiency of Japan's beef production is comparatively low. As a result, the expansion of beef imports has been a major focus in trade negotiations of Japan with Australia, New Zealand, and the United States.

Beef imports are severely restricted to protect inefficient domestic production. A majority of Wagyu cattle raisers live in the remote, depopulated areas of Kobe and Matsuzaka. They typically raise a few head of cattle as a sideline of subsistence farming. Feeding periods may be as long as 30 - 35 months. The productivity of such operations is low and the production costs high.

Irrespective of the low production efficiency, raising cattle is a critical source of income for farmers in these areas. Because electoral votes in depopulated districts are over represented in the National Diet, political necessity as well as welfare considerations require the protection of the domestic beef industry. To protect the domestic producers, the government supports the domestic wholesale price of beef within a "price stabilization zone" of floor and ceiling prices. The policy instrument used to maintain beef prices within the zone is the control of supply by means of an import quota (Longworth,

1976, 1978).

The Monopoly Model. Japan has created a monopoly in importing beef through the allocation of import quotas to one trader. Currently, all beef imports (except about a 10% share of the general quota) are monopolized by the Livestock Industries Promotion Corporation (LIPC). It is assumed that Japan's objectives in establishing a beef import monopoly are: (1) to encourage a desired level of domestic production of beef; (2) to secure a target internal price for beef producers; (3) to secure a desired degree of protection for domestic producers (i.e., a desired proportionate excess of the price for producers over the international price of the product); (4) to obtain a desired reduction in the level of imports; and (5) to reserve a specified proportion of the domestic market for domestic producers (Snape, 1986).

Snape illustrates that a monopolistic importer that seeks to maximize profits will restrict imports until the marginal cost of imports is equal to the marginal revenue obtained from selling the imports on the home market (i.e. after allowing for the response of domestic producers as well as consumers). This restriction of imports will raise the domestic price to both producers and consumers and will encourage domestic production. In Figure T1, the Japanese beef import situation is illustrated as a case where the LIPC behaves as a monopolistic producer and importer under profit maximization. Total demand is  $D$ ,  $MR$  the marginal revenue,  $S_M$  the supply of imports,  $MC_M$  the marginal cost of imports, and  $MC$  the marginal cost of domestic production  $MC + MC_M$  is the horizontal sum of the two marginal costs.

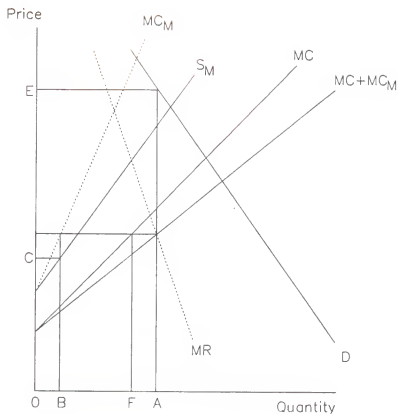


FIGURE T1: Monopolistic Beef Importing by the Japanese Livestock Industry Promotion Corporation.

The profit-maximizing configuration is total sales of  $OA$  (at a price of  $OE$ ),  $OB$  being imports (obtained at a price of  $OC$ ) and domestic supply being  $BA$  ( $=OF$ ). If the monopoly is created by an import quota, and if the import quota is greater than  $OB$ , then the quota will not be fully used as only  $OB$  will be imported. If the import quota is less than  $OB$ , the quota will be fully used and the monopolist will not have effective control over imports-control lies with those who determine the size of

the quota.

Trade Agreements in Japanese Beef Trade. Beef trade flows between Japan and the United States, Australia, and New Zealand are influenced by political economy issues which determine trade shares. Even with intense domestic political pressure to protect its domestic agriculture, Japan participated in the Tokyo Round of Multinational Trade Negotiations and agreed to a number of agricultural trade concessions. During bilateral trade agreements with the United States, Japan agreed to gradually to increase the annual importation of high quality beef from 16,800 metric tons in 1978 to 39,800 by Japanese fiscal year 1983 (Lloyd et al., 1987). The agreement left the existing beef import quota system unchanged as it only increased the proportion of the quota allocated to high quality beef. This action favored the United States beef exporter over their Australian and New Zealand counterparts since the United States dominates high quality beef trade.

Following the Tokyo Round, the United States and Japan held a series of bilateral negotiation and Gatt Article XIII consultations. The meetings culminated in April 1984 with a new agreement on beef imports. This agreement called for a gradual increase of 27,600 metric tons of high quality beef imports up to an annual import quantity of 58,400 by 1987 (Lloyd et al.).

Livestock Industry Promotion Corporation. The Livestock Industry Promotion Corporation (LIPC) is a quasi-government economic corporation attached to the Ministry of Agriculture, Forestry and Fisheries (MAFF).

Its main purpose is to administer price stabilization and deficiency payment schemes for livestock products. In addition, it is charged with handling funds for modernization and development of the livestock industry. Today, LIPC's duties relating to beef as specifically set forth by law are: (1) price stabilization of livestock products through the purchase, sale and storage of domestic and imported beef, (2) direct subsidization or investment in designated assistance projects, and (3) promotion of demand for livestock products (LIPC, 1983).

The LIPC is empowered by the Japanese Government to purchase, exchange, sell and store domestic or imported beef for price stabilization. The Government through the MAFF sets a price stabilization zone which the LIPC is to maintain. The LIPC can influence the quantities of beef on the wholesale market through the purchase and sale of imported beef. The price stabilization program and its administration is a key factor in the determining beef imports and protecting Japanese beef producers (Lloyd et al.).

Japanese Beef Trade Barriers. The government of Japan has implemented a number of trade barriers to limit importation of agricultural products. Barriers to importing beef limit quantities to the extent that the domestic Japanese beef producers are afforded considerable protection against relatively more efficient foreign producers. These barriers include well-known categories such as tariffs and quotas, plus the generic category of nontariff barriers (NTBs). There is an ad valorem tariff (25 percent) imposed on all imported fresh, frozen, chilled and boiled beef. The tariff has not

been changed in any of the multilateral trade negotiations rounds or bilateral trade negotiations. The LIPC also imposes certification standards on all imported beef. These standards add extra handling, trimming and grading costs to importers.

In addition to the tariff and certification standards, the Japanese beef industry is also protected by quotas. In Japan's case the quota is probably the most important factor restricting imports. Quota tonnage for beef is determined by the Ministry of Agriculture, Forestry and Fisheries (MAFF) after consultation with the Ministry of International Trade and Industry (MITI) and Livestock Industry Promotion Corporation (LIPC) (United States Meat Export Federation, 1984).

Japan regulates beef imports with a general quota and four special quotas. Australia supplies 69 percent of the general quota, the United States 28 percent and New Zealand 3 percent. These shares are equivalent to the LIPC share of the general quota (which is 90% of the total). The LIPC imports beef through public tenders which are issued approximately once a month. The tenders are for grain-fed beef which is supplied primarily from the United States, grass-fed beef supplied mostly from Australia and New Zealand and other beef products.

The LIPC imports beef through several different systems. The primary system (80% of the LIPC quota) is the "merchant system" where the LIPC acts as the purchasing agent and requests competitive bids on specific quantities and cuts of beef directly from importers licensed to import beef into Japan. Foreign suppliers bid on LIPC tenders through one of 36 Japanese importing companies which are granted

importing licenses from the MITI. These companies request competitive bids from foreign suppliers to fill their share of the tender limit. The LIPC then purchases the beef from the importers with the lowest price subject to the company's ability to meet product specification guidelines.

The second procedure is the "one touch" system which was established to promote the retail sale of imported chilled beef at reasonable prices. Currently United States has only a ten percent share of chilled beef imports (Gustafson, 1987). This system is used to supply imported chilled beef to some 3000 retail stores in the Designated Stores Program. Participating stores are authorized by the LIPC to import a specified quantity of chilled beef from licensed importers. These retail stores contact the licensed importing companies which solicit bids from foreign suppliers. After the importer and retailer agree on a price, the proposed deal is submitted to the LIPC which inspects the beef, collects the payment plus a levy from the participating store and pays the importer. The licensed importers deliver directly to the Designated Stores Program participants thereby reducing the LIPC's storage costs. The LIPC is trying to reduce the share of beef imported under this system to increase its control over imports (Gustafson).

The third major means available to the LIPC for importing beef is the "modified tender" system. Under this system the LIPC purchases imported beef for the Federation of All Japan Meat Retailers Cooperative Association (Zennikuren). The LIPC purchases the beef from the lowest priced licensed importer based upon each importers share of

the import limit. "This system was instituted to establish a closer match between domestic demand and imported beef" (Lloyd et al., pg. 28).

The fourth means by which the LIPC can fulfill its quota is the "simultaneous buy and sell" system. This system excludes chilled beef and was instituted by the LIPC in 1985 following the Japanese-United States Beef Agreement (Lloyd et al.). Under this system, the LIPC announces to user associations the maximum quantity they can offer in a particular tender. User associations and foreign suppliers negotiate price, quantity, specifications and type of beef. Bids and offers are tendered to the LIPC. If the negotiated price agreements fall within a designated price range, the tender will be accepted and notices issued on buy/sell awards. The amount of beef imported under this system is limited to 10 percent of LIPC's quota (Lloyd et al.).

The private quota, which is not controlled by the LIPC, consists of approximately ten percent of the general quota. Approximately 70 percent of this quota is allocated to the 36 beef importers who are obligated to sell to Zennikuren. Both frozen and chilled beef can be imported but most imports consist of high quality cuts from the United States. The remainder of the private quota goes to the Japan Ham and Sausage Manufacturers Cooperative Association and the Japan Meat Canners Cooperative Association on a two-to-one basis, respectively.

A number of special quotas, outside the control of the LIPC, have been established to meet the needs of specific end users. The special quotas amount to about 10 percent of beef imports and are distributed as the Hotel, Okinawa, School Lunch and Boiled Beef quotas. Unlike the



general quota, the special quotas are not global and specific supplying countries may be designated (Lloyd et al.). The Hotel quota is administered by the Japan Hotel Association and is currently dominated by one United States packer (Gustafson). The Okinawa quota administered by the Importers and Users Association for beef imports only to Okinawa. The School Lunch quota is assigned to the Japan School Lunch Association which supplies imported meat to the national school lunch program from Australia. The Boiled Beef quota is established to import beef for manufacturing use. Australia currently fills most of this quota.

Summary. Quotas (except for special quotas) are not allocated to specific countries, thus each country must compete for its share. However, when quota specifications are for high quality beef, the United States is favored since USDA grade prime and choice automatically meet the requirements (Gustafson). Quota specifications for chilled and lower quality beef favor the Australians who have a cost advantage over the United States. Thus once the size of the quota is established by the LIPC, negotiations between Japan and the importing countries determine import trade shares. Agreements stipulate the minimum amount of high quality beef which will be imported under already established quotas. The United States fills most of the high quality beef category leaving other countries less of the general quota available to them. Intense negotiations concerning beef trade between the United States and Japan increased high quality beef imports under the general quota by 3,300 metric tons per year

until 1984 (Destler and Sato, 1982). In April 1984 the agreement was extended to increase the total import quantity by 6,900 metric tons per year to 58,400 metric tons by March 1988. (Lloyd et al.).

One would expect that the United States has gained market share from the Australians given the recent bilateral agreement with Japan which favors high quality beef imports. The extent to which recent trade negotiations have favored the United States over the Australians will be formally analyzed using Markov processes. This technique can be used to determine if changes in market shares can be attributable to trend or to trade negotiations.

## LITERATURE REVIEW

The purpose of the following literature review is to provide background information for the current study of Japanese beef imports. The reviewed literature is divided into three subsections specifically concerned with Japanese beef markets, market share analysis techniques and Markov processes. In the first subsection, the reader is given a better understanding of Japanese livestock and meat markets. The second subsection describes several different market share analysis techniques, and the final subsection provides a detailed look at Markov processes.

Characteristics of the Japanese Beef Market. Japanese beef markets have come under a great deal of attention from major beef exporting nations in recent years. Japan's rapid growth in income and relatively low per capita meat consumption have convinced exporters that substantial market opportunities exist beyond current levels of trade. According to Longworth (1983), dietary changes in Japan began to occur in the mid-1950s and were especially apparent throughout the income-doubling decades of the 1960s and 1970s. The most dramatic of these changes has been the growth in per capita consumption of livestock and poultry products. Over the 20 year period from 1960 to 1980, per capita consumption of eggs increased nearly 250 percent, milk and dairy product consumption grew by almost 300 percent, and annual consumption of meat increased by 450 percent. The growth in meat consumption was not evenly divided among poultry, pork and beef. In 1955, 50 percent of the meat consumed in Japan was beef. By 1980, beef

consumption represented less than 20 percent of total meat consumption. The high relative price of beef and its limited availability caused beef consumption to become a smaller portion of total meat consumption. During the period, Japanese production of pork and poultry kept a close pace with demand, while beef production lagged demand by a substantial margin. Formidable trade restrictions limited beef imports and nominal prices increased more than twice as fast as prices of either pork or poultry. Real prices of pork and poultry meat have actually declined since 1960. Despite the price barrier and availability problems, per capita beef consumption in Japan has continued to grow, indicating that Japanese consumers have a strong desire for beef.

Japan's Agricultural Policy Research Committee (1986) acknowledged that beef consumption is on the rise, but submitted that the current import system had approval of the general populace. They also maintained that unlimited imports create confusion in the marketplace and strike a heavy blow against domestic beef producers. The Japanese government is firmly committed to the modernization of beef cattle production and hopes to produce domestically as much of the nation's consumption as is feasible. Japanese agricultural policies generally reflect concern for food security and food price stability. Japanese policy makers feel this philosophy is in line with policies of other developed nations which also limit agricultural imports.

A number of economic researchers have sought to examine Japanese markets with most research efforts directed to the explanation of Japan's feed-livestock economy, meat consumption patterns, import regulatory policies and potential for increased meat imports. Coyle

(1983) made an extensive examination of Japan's feed-livestock economy. Included in this analysis is both historical and current developments in the beef, pork, poultry, dairy and fishing industries. Coyle also described domestic feed production in Japan and the continuing need for imported feedstuffs. He made projections for Japanese production, and imports were made based on current trends, government policies and expected future development in the domestic livestock and feed sectors.

Coyle found the future consumption of livestock and poultry products most dependent on continued income and population growth. Growth in per capita consumption of red meat has increased faster than growth in per capita consumption of fish and will continue to do so through 1990. Fish remains the most important source of protein in the Japanese diet. However, annual catch volume has remained relatively stable since 1972, and real prices of fish have increased faster than for any other meat product.

Coyle states that imports of beef and dairy products are likely to increase while imports of pork and poultry will decline. Japan's ability to expand beef and dairy production has been seriously limited by the amount of land available for pasture and forage production. Coyle predicted that self-sufficiency in beef will decline to about 50 percent by 1990 as a result of growing consumption, land constraints and reduction in dairy cow numbers, due to increased per animal productivity (currently, 70 percent of beef production in Japan comes from dairy animals). In contrast, rapid structural changes have occurred in the hog and poultry industries making Japan more competitive in pork, poultry meat and egg production. Increased use of

confinement and concentration in pork and poultry production will keep self-sufficiency in these products at or above 90 percent.

An explanation for dissimilar performance between the Japanese beef sector and its hog and poultry industries was noted by Longmire (1984). Longmire reasoned that technology associated with factory-like production processes (such as confined feeding operations) are more readily transferrable than production technologies utilizing extensive land use and specialized labor. Coyle concluded that heavy dependence on imported feedstuffs, both as preformulated feeds and bulk commodities, will continue and the United States will remain an important supplier. The Japanese government is highly committed to the expansion of domestic forage production, but success in this area is expected to be minimal.

A grain, oilseeds and livestock (GOL) model for Japan has been developed by Liu (1985). Patterned after the United States GOL model, this model is used to evaluate trends in Japan's grain, oilseeds and livestock economy as well as for making projections under alternative economic and policy assumptions. Liu's GOL model is an annual simulation model which includes 19 agricultural commodities. Simulation of production, consumption, stock changes, trade and prices are included and explicit cross-price effects among commodities are accounted for.

The model was simulated through the year 2000 (base simulation) assuming a 0.5 percent annual increase in population, a 4.5 percent yearly increase in per capita income, a 7.5 percent increase in the consumer price index and all other price indices, and a 5.6 percent

increase in both the index cost of production and all crop input prices. Continuation of current trade policies was also assumed, but beef imports were allowed to increase at a rate of 5 percent per year. A second simulation assumed identical conditions except that all restrictions on beef imports (both tariffs and quotas) were removed. Compared to the base, removal of all beef import restrictions caused imports to more than double by 1990 and more than triple by 2000. Domestic beef prices fell by 29 percent, but projected beef production in Japan decreased by only 6 to 9 percent. Lower beef prices reduced demand for all other livestock and dairy products as well as the need for imported feed grains.

Using a simple demand-supply model for beef in Japan, Hayami (1979) suggested a policy under which beef imports could be liberalized without jeopardizing producer incomes or imposing a heavy burden on the government budget. Williams (1985) reached a similar welfare conclusion using a proposed policy much like that of Hayami. Hayami's proposed policy used a system of deficiency payments and moderately higher levy and tariff rates (550 yen per kilogram, compared to current rates of 480 yen per kilogram), combined with abolition of all import quota restrictions. The additional revenue generated from higher import tax rates and increased import volumes could be redistributed to beef producers in the form of deficiency payments, and domestic prices would be maintained.

Welfare effects of such a policy were evaluated under assumption that the price elasticity of beef demand ( $E_b$ ) in Japan is either -1.5 or -1.0 ( $E_b = -1.5$  represents an average of estimates from several

studies, while  $E_b = 1.0$  is close to the minimum of all estimates). Additionally, it was assumed that the program would be gradually phased in over a six year period. Immediate and long term benefits were noted under either elasticity assumption as deficiency payment costs were more than covered by additional revenue generated from the import taxes on imported beef. Both domestic beef production and beef prices rose by the end of the period as world beef demand increased as a result of greater Japanese purchases. The Japanese consumer was the major beneficiary, enjoying an increase in consumer surplus of 300 to 400 billion yen (1.5 to 2.0 billion U.S. dollars). Net social welfare increases ranged from 150 to 200 billion yen and exceeded by a wide margin estimated administrative costs associated with deficiency payment allocation.

Williams' (1985) evaluation of alternative Japanese import policies proposed policy used a 48-simultaneous equation, annual econometric model of the Japanese livestock sector. Alternative policies included the use of beef producer deficiency payments funded out of general tax revenues and removal of all import quotas, a beef producer deficiency payment funded by a 25 percent tax on beef imports and no quota, and a 25 percent import tax alone. The model was used to simulate effects that such policies might have had if they had been in place during the ten year period 1973 through 1982. Simulation results were compared to actual figures to determine alternative policy impacts and as a basis for assessing the impact of future policy changes.

Williams' analysis confirmed that Japanese import policies have supported domestic Wagyu (indigenous Japanese beef cattle) production



through raising internal beef prices and that the U.S. share of Japanese imports has been adversely effected.

The deficiency payment program, when funded from general tax revenue, had little effect on Wagyu production, and cost \$U.S. 1.3 billion for the ten year period. Beef imports would have likely been 2.0 metric tons per year higher under these conditions. The use of a 25 per cent import tax generated more than sufficient revenue to fund the deficiency payment program, however, annual imports would have been only 1.0 metric tons greater than actual import figures for the 1973 to 1982 period. Any abrupt policy change, such as abandonment of the quota system (even with the 25 percent import tax maintained) would cause Japanese beef prices to drop, likely forcing herd liquidation and reducing domestic beef production. Phased liberalization was recommended as the best alternative. A system which systematically reduced the difference between world beef prices and Japanese beef prices, after ten years, allowed imports to rise to the level of immediate quota withdrawal while maintaining domestic cattle production. Williams concluded that alternative policies which gradually allow greater beef imports have little adverse impact on domestic beef production and producer incomes in Japan.

Anderson (1983) concluded that policies such as those proposed by Hayami and Williams are not likely to be implemented, because such policies would transfer to beef producers much of the profits currently received by the import agency and beef wholesalers. These profits have been quite large (\$U.S. 150 to 300 million annually), and may to quiet a group that would otherwise lobby for fewer import restrictions.

Currently, the Japanese government allows these middlemen to purchase imported beef at world prices and then to receive a substantial markup by selling domestically at protected price levels. According to Anderson, any change in policy, such as abolition of quotas, that would reduce profit margins for this group is likely to be met with resistance.

During the late 1970s and early 1980s, the United States intensified pressure on Japan to liberalize agricultural import policies. Trade negotiations were held between the two countries during the early 1980s. In 1984, an agreement known as the United States-Japan Beef and Citrus Understanding was reached, and accusations from the United States were temporarily abated. Under this agreement, the quantity of high-quality beef imported by the Japanese was to be expanded by 6,900 tons per year (17 percent annual increase) during 1984 to 1987. This rate is slightly faster than the 16 percent annual increase rate established by a previous agreement for the period 1979 to 1983. Under a similar agreement between Japan and Australia in 1984, the general beef quota was expanded by 9,000 tons per year (6 percent) for 1984 to 1987 (up from 1,625 tons per year, 4 percent, for 1979 to 1983). Since high-quality beef imports are subject to the general quota, the United States-Japan agreement guarantees that 77 percent of the expansion in the general quota will come in the form of high-quality beef of which the United States is the largest supplier. The Japanese government also committed themselves to facilitate of interactions between foreign beef suppliers and domestic users. This commitment lead to the initiation of the "Simultaneous Buy-Sell" system which allowed end

users to negotiate directly or through the Japanese Livestock Industry Promotion Council with foreign suppliers about beef product specifications and prices.

Coyle (1986) made an evaluation of the 1984 agreement and discussed implications for the United States. Coyle provides historical perspectives as a backdrop for his evaluation. Japanese concerns about food self-sufficiency and food security were mentioned as underpinnings to the nation's import policies. The United States was noted as viewing Japanese quotas on beef and citrus products as symbolic of the broader and ongoing problem of agricultural protectionism in Japan. Expanded quotas provided by the agreement will likely add \$35 to \$45 million in annual U.S. farm exports. However, Japanese beef imports will remain about 30 to 60 percent of what they would be under free trade.

Mori (1986) criticized the Coyle's findings, stating that Coyle's analysis was based on the assumption that any beef is beef in Japan. Mori states that that assumption leads to an overestimation of the degree to which Japan protects its domestic beef industry. Mori submits, based on correlation of past price movements, that United States "fed" beef is a different commodity than first grade Wagyu beef and is probably not even a suitable substitute for second grade Japanese dairy steer beef. Miyazaki (1986) supports Mori's conclusion on the difference between United States "fed" beef and top grade Wagyu beef, but equates U.S. beef to the medium grade of beef in Japan. This grade includes 38 percent of all dairy steer beef (with most of the remaining 62 percent falling in lower quality grades) and 44.9 percent of all Wagyu beef. Hence, it is unclear exactly where U.S. beef falls

with regard to quality in Japanese markets. This market is, apparently, highly segmented (Mori, 1986) which may account for part of the price differentials seen between imported and domestic beef.

Despite its many import restrictions, Japan remains one of the largest and most stable foreign markets for United States livestock products. The Japanese are the single most stable importer of United States beef and veal exports, accounting for 65 percent of total United States exports in beef and veal. Japan is also a leading importer of United States livestock offal. With beef consumption increasing in Japan and with import quotas gradually being reduced, Seng (1984) believes substantial payoffs await United States beef exporters who are willing to be committed to the Japanese market. As Asian Director of the United States Meat Export Federation (a privately funded, not-for-profit export enhancement organization), Seng notes several strategies for increasing beef exports to Japan.

Foremost on the part of the exporting organization is a total commitment to the Japanese market. The exporter must be particularly committed to the development of market information and give similar allegiance to marketing and promotion as well as production and packaging. This commitment should be coherent and long-term in nature as little will be accomplished with a sometime, short-term commitment.

Currently, Japanese import policies reduce the ability of United States beef exporters to compete directly with other beef exporters on the basis of price alone. Therefore, to the extent possible, the United States should strive to distinguish its beef on the basis of quality, innovation, packaging and promotion. Seng believes that the

United States needs to ensure that its exports are perceived as a consumer product rather than a commodity. Beef from the United States does have several inherent strengths in the Japanese market, such as relative leanness and lack of objectionable cooking odors as found in some lower priced, imported meats. The high degree of sophistication in the United States packing industry should provide the ability to custom fabricate products to the Japanese market. It will also be important to study product and service needs and specific export opportunities in Japan, and to develop contacts with government trading companies, wholesalers, retailers and end product users. According to Seng, promotional efforts should be primarily directed to consumers and distributors as enhancement of demand at these levels is imperative to success.

Market Share Analysis Techniques. Several types of market share analysis techniques can be found in recent economic literature. A simple market share analysis technique is the calculation of market share proportions for major sellers in a particular market coupled with an evaluation and discussion of trends in each seller's market share. Webb (1981) used this type of market share analysis to evaluate world trade in major United States crops. A large part of Webb's study is devoted to the presentation of the information using pie graphs, line graphs and market share tables depicting trends in market shares over a specified period of time. Discussion of the exporter's current market position and trends which have occurred are also included in the analysis. Policy, demand and supply related variables are utilized to

explain observed positions and trends.

Linneman (1966) used a model in which the volume of trade of a specific commodity between a certain exporter and importer was made dependent on supply factors in the exporting nation, demand factors in the importing nation and resistance factors which hinder trade between the two countries. The model was designed to provide predictions when exogenous forecasts of population and income growth are available. This type of analysis has been called gravitational, because it looks only at conditions in the trading countries and does not directly consider conditions in competing exporter and importer nations. Lack of disaggregated trade information have limited the use of gravitational models in agricultural economic research.

The constant market share (CMS) approach has been used by Richardson (1971), Rigaux (1971), and Konandreas and Hurtado (1978), and others, to analyze historic agricultural trade patterns. Reseachers using CMS models attempt to explain changes in trade flows according to changes in total market growth, growth in individual import markets and changes in preferential arrangements. The total change in exports is generally written as a sum of three or four terms (depending on data availability) which describe total and individual country growth and bilateral trade agreements. Each one of the explanatory terms is allowed to vary, while the remaining terms are held constant. Predictions for future trade shares are based on historically observed shares. The CMS approach is useful as a proxy for groups of aggregated commodities, but it is inappropriate for individual agricultural commodities due to the extreme volatility which exists in year to year

market shares for the major exporters (McCalla and Josling, 1981).

A fourth type of analysis based on market shares and having predictive power is an adapted Markov process as first applied by Tesler (1962). In the Markov model the market share of a certain exporter during a given time period is said to be dependent upon the market shares of all other exporters during the previous period (including the specified exporters own market share from the previous period). The analysis results in the development of transition probabilities, which denote the probability that the importer will switch from one exporter to another. The markov model is generally considered an improvement over the CMS method (McCalla and Josling, 1981), however, it may lose accuracy as the forecasting period is extended (Howard, 1971). A Markov model is used in the current study to analyze Japanese beef imports. The final section of the literature review has been devoted to a more detailed examination of Markov processes as it applies to economics and, more specifically, to international trade.

Markov Processes. Dynamic economic models often describe the outcome of certain variables as dependent upon the preceding value of the same variable. First order Markov processes, which assume that current values of economic variables depend only on the lagged value of the same variable, can be applied to a wide spectrum of economic phenomena, given that time ordered data is available. Markov models have been used to evaluate the distribution of wages and income (Solow, 1951), size distribution of firms (Judge and Swanson, 1962; Kottke, 1964) and changes in market structure (Padberg, 1962; Farris and Padberg, 1964).

A first order Markov process assumes;

$$S_j(t) = P_{ij}S_i(t-1),$$

or across all  $S_i$ ,

$$S_j(t) = \sum_i P_{ij}S_i(t-1),$$

where;

$S$  = the  $r$  states or possible outcomes;  $i = 1, 2, \dots, n$ ,  
 $j = 1, 2, \dots, n$ , and

$P_{ij}$  = the transition probability denoting the probability that the process will move from its current state,  $S_i$ , to another state,  $S_j$ , in the next time period. Hence,  $P_{ij} = \Pr(S_j(t+1)/S_i(t))$ .

Notice that because a finite, first order Markov process assumes a fixed number of possible outcomes or states;

$$P_{ij} = 1, \text{ and } 0 \leq P_{ij} \leq 1 \text{ for all } P_{ij}.$$

When the Markov model is applied to economic data which includes the actual number of movements  $S_i(t)$  to  $S_j(t+1)$  for all  $i$  and  $j$ , the maximum likelihood estimator for  $P_{ij}$  is;

$$P_{ij} = [ n_{ij} / \sum_i n_{ij} ]$$

where,

$n_{ij}$  = the number of observed movements from  $S_i$  to  $S_j$   
for all  $i$  and  $j$ .

Padberg (1962) applied this model to the wholesale fluid milk industry in California for the period 1950 to 1960. Judge and Swanson (1962) used the same model to examine industry concentration of hog producing firms in central Illinois from 1946 to 1958. In both studies, estimates of transition probabilities were easily obtained, because the actual number of movements from one state to each other state was known. These researchers noted that under the assumption of constant transitional relationships (constant over the estimation



period), a unique equilibrium for each system would eventually be reached. This equilibrium was found to be independent of the initial condition of the system, and was, therefore dependent only upon the estimated transitional relationships.

Padberg demonstrated this outcome for an imaginary industry having an initial configuration ( $C_{t1}$ ) of 100 firms in each of two categories. Supposing annual movement between categories is described by the transition probability matrix;

$$P = \begin{vmatrix} .6 & .4 \\ .3 & .7 \end{vmatrix},$$

the expected industry configuration in the second time period ( $C_{t2}$ ) is,

$$C_{t2} = C_{t1}P = (100, 100) \begin{vmatrix} .6 & .4 \\ .3 & .7 \end{vmatrix} = (90, 100).$$

Likewise, the industry configuration in the third period is given by;

$$C_{t3} = C_{t2}P = C_{t1}P^2 = (90, 110) \begin{vmatrix} .6 & .4 \\ .3 & .7 \end{vmatrix} = (87, 113),$$

and it follows that,

$$C_{tn} = C_{t1}P^n.$$

As  $n$  approaches a positive infinity,  $P^n$  converges on a unique vector  $K$ , which represents the final probability of being in each of the two categories. For Padberg's example;

$$K = [.4268 \quad .5714],$$

and equilibrium for the imaginary industry is;

$$C_{t1}K = (100, 100) \begin{vmatrix} .4286 & .5714 \\ .4286 & .5714 \end{vmatrix} = (87.71, 114.29).$$

The number of firms in each category will remain stable when equil-

ilibrium is reached, and this equilibrium occurs when category one contains 88 firms and category two contains 114 firms. As mentioned, this equilibrium is independent of initial industry configuration. Any  $C_{t1}$  when multiplied by the vector  $K$  will result in the same equilibrium number of firms in each of the two categories as long as the chosen configuration involves the same total number of firms.

A problem in applying a first order Markov model exists when complete data concerning the individual movement between states is unavailable for each successive time period within the time block to be analyzed. Often only aggregate outcome data is available. This data quantifies the proportion of the total population in each state during each successive time period, but provides no detail about movement between individual states.

Miller (1952) suggested that transition probabilities could be estimated using ordinary least squares when such data limitations exist. Adding an error term,  $u_{it}$ , to the previously examined Markov equation results in the multivariate linear model;

$$S_j(t) = \sum_j P_{ij} S_i(t-1) + u_{it},$$

or in matrix form,

$$S_j = PS_i + U,$$

where,

$S_j$  - a  $(Tx1)$  vector of observations denoting the proportion in state  $j$  at time  $t$ ,

$S_i$  - a  $(Txr)$  matrix of observed proportions in state  $i$  at time  $t-1$ ,

$P$  - a  $(rx1)$  vector of unknown transition probabilities,

$U$  - a  $(Tx1)$  vector of random disturbances, and

T = the total number of successive time periods involved.

As long as  $T > r$ , the least squares approach toward finding the solution to the matrix form of the model is to find estimates,  $P_{ij}$ , for  $P_{ij}$  such that  $U'U$  is minimized in the quadratic form of the equation;

$$U'U = (S_j - PS_j)'(S_j - PS_j).$$

There are, however, several problems associated with the estimation of transition probabilities using ordinary least squares. Mandansky (1959) pointed out that the disturbance terms,  $u_{it}$ , do not all have the same variance. Hence, the variance-covariance matrix associated with these error terms does not satisfy the least squares assumption that the variance-covariance matrix of the disturbance terms is equal to  $\sigma^2 I$ . Violation of this assumption results in asymptotically inefficiency among the estimates. Mandasky suggested a transformation of the error terms to improve the efficiency of the estimates. However, there is still no guarantee that the least squares estimates will meet the required criterion;

$$\sum_j P_{ij} = 1 \text{ and } p_{ij} \geq 0.$$

Non-admissible estimates may appear, because individual least squares estimates may be negative or greater than one. Goodman (1953) and Tesler (1963) used ordinary least squares to estimate transition probabilities, then made adjustments on the estimates which violated the assumption  $0 \leq p_{ij} \leq 1$ . The adjustment procedure consisted of assigning the extreme permissible value to the inadmissible values and a subsequent reestimation of the linear model. All negative estimates were adjusted to zero, while all greater than one estimates were

adjusted to unity. Iteration will be required when more than one estimated transition probability must be adjusted. Further, due to the number of possible alternatives when adjustments need to be made on several estimates, adjustments must be made somewhat arbitrarily. It seems reasonable that ordinary least squares could be utilized to find estimates for the unknown transition probabilities, if the necessary estimate restrictions could be imposed on the model. However, the inequality constraint,  $0 \leq p_{ij} \leq 1$ , is incompatible with the classical Lagrangean approach to least squares minimization (Lee et al., 1965).

The equation,

$$U'U = (S_j - PS_i)'(S_j - PS_i) - \\ S_j'S_j - 2P'S_i'S_j + P'S_i'S_iP,$$

appears as a quadratic form of  $P$ , and because the required constraints on  $P$  are linear, the problem is solvable through quadratic programming. This method provides a straightforward and objective means of deriving admissible estimates for the unknown transition probabilities which minimizes the total sum of squared errors (Lee et al., 1965). Theil and Rey (1966) used a quadratic programming approach to estimate transition probabilities for the changes in market shares held by three cigarette brands from 1925 to 1943. Solving the quadratic form of the markov model with no restrictions on the transition probability estimates, Theil and Rey found that the required criterion  $\sum_j p_{ij} = 1$  was already satisfied. Therefore, imposition of this constraint was not necessary. Several negative estimates did appear, however. Restriction were imposed only on the violating estimates (negative estimates were forced to zero) and the modified Lagrangean expression

was subsequently solved.

The literature contains two economic studies that contain a quadratic programming solution for an application of Markov processes to international trade in agricultural commodities. Dent (1967) examined the international wool flows which occurred during 1950 to 1964. Nearly 20 years later, Wilson et al. (1986) analyzed importer buying behavior for several major wheat importing countries. Both studies have similar objectives and methodology to the author's analysis of Japanese beef imports.

Dent (1967) applied a first order Markov model to international wool trade. A quadratic programming approach like that of Theil and Rey (1966) was used to estimate transition probabilities for exporter market shares of the total imports for each of seven major wool importing nations. Dent suggested that the estimated transition probabilities reflect importer buying loyalty toward individual suppliers and give some idea to the extent of substitution between exporters. Future buying paths for the importing countries was also discussed. Dent makes use of the convergence vector or equilibrium vector which exist under the assumption of constant transitional relationships to explain probable future buying patterns for the importers. He also noted that the impact any changes in the transitional relationships which resulted from increased promotional efforts or research developments could be quantified through alteration of the appropriate transitional probabilities. Such alteration would change the equilibrium vector and would alter the expected buying pattern of the importer targeted by the promotional and research efforts.

Wilson et al. (1986) used the Minos quadratic programming algorithm (a quadratic programming computer package) to estimate transition probabilities for exporter market share of the total imports of several major wheat importing nations. Wilson et al. set out to characterize importer loyalty toward individual suppliers and to use this information to assess the extent of competition in the international wheat market. Results indicated that wheat imports from different exporters are rarely considered to be perfect substitutes, and that overall market competitiveness is, therefore, reduced.

## METHODOLOGY

Transition probabilities are estimated for Japan's beef importing behavior. Additionally, beef prices are compared between Japan's beef suppliers. The methodology associated with the completion of these tasks is presented in this chapter. The chapter is divided into two subsections. In the first subsection, an application of Markov processes and the Minos quadratic programming algorithm is used to estimate the desired transition probabilities. The second subsection details the use of a paired t-test for comparison of beef prices among the major Japanese beef suppliers.

Estimation of Transition Probabilities. Japan's loyalty toward its individual beef suppliers can be estimated by Markov processes, if it is assumed that the importer's decision concerning the choice of a beef supplier is governed by a probabilistic mechanism. This assumption is reasonable, because there are a finite number of beef exporting countries in the world, and because Japan must choose at least one of them if beef is to be imported. Hence,

$$\sum_i^n [\text{Pr}(\text{CS}_i)] = 1$$

where,

$\text{Pr}(\text{CS}_i)$  = the probability that the importer's choice of supplier is country  $S_i$ ;  $i = 1, 2, \dots, n$ , and  $n$  is the finite number of nations which export beef.

It follows that;

$$0 \leq \text{Pr}(\text{CS}_i) \leq 1, \quad \text{for each } i,$$

and the likelihood that a particular supplier will be chosen can be expressed by a stochastic process.

The stochastic process of a finite, first order Markovian probability model

can be expressed;

$$\Pr(S_t/S_{t-1}) = \Pr(S_t/S_{t-1}, S_{t-2}, \dots, S_0)$$

where,

$S$  = the state or outcome of a particular event,

$t$  = the time period associated with an event;  $(t-1)$  represents the time period previous to  $t$ , and

$\Pr(S_t/S_{t-1})$  and  $\Pr(S_t/S_{t-1}, S_{t-2}, \dots, S_0)$  are conditional probabilities for the outcome  $S_t$ .

Outcomes  $S_t$  and  $S_{t-1}$  are now more specifically defined to be the  $j$ th outcome at time  $t$ ,  $S_j(t)$ , and the  $i$ th outcome at time  $t-1$ ,  $S_i(t-1)$ , respectively, where  $i = 1, 2, \dots, n$  and  $j = 1, 2, \dots, n$ . Statistical theory defines the joint probability of  $S_j(t)$  and  $S_i(t-1)$  as;

$$\Pr(S_j(t), S_i(t-1)) = \Pr(S_i(t-1))\Pr(S_j(t)/S_i(t-1)).$$

where,

$\Pr(S_i(t-1))$  = the unconditional probability for the outcome  $S_i(t-1)$ .

Aggregation of this equation over  $i$  gives the unconditional probability for the outcome  $S_j(t)$ ;

$$\Pr(S_j(t)) = \sum_i^n \Pr(S_i(t-1))\Pr(S_j(t)/S_i(t-1))$$

where,

$\Pr(S_j(t))$  = the unconditional probability for outcome  $S_j(t)$ .

The conditional probability,  $\Pr(S_j(t)/S_i(t-1))$  can be defined as the constant transition probability associated with a change from  $S_i(t-1)$  to  $S_j(t)$ .

Rewriting the stochastic process as a Markovian Probability model;

$$S_{jt} = \sum_i^n S_{it-1}P_{ij}$$



where,

$$S_{jt} = \Pr(S_j(t)),$$

$$S_{it-1} = \Pr(S_i(t-1)), \text{ and}$$

$$P_{ij} = \Pr(S_j(t)/S_i(t-1)).$$

For the purpose of this study, the outcomes of interest are the annual market shares held by individual nations exporting beef to Japan from 1960 to 1985. Japan's major beef suppliers are Australia, New Zealand and the United States. At no time during 1960 to 1985 did the remainder of beef exporting countries hold a combined share of more than a 10.5 percent of Japanese beef imports. Therefore, market shares for Australia, New Zealand, the United States and a fourth supplier designated "ROW" or "rest of the world" are included in the analysis. Both market share of the total quantity of Japanese beef imports and market share of the total value of beef imports are evaluated. The Markov probability model is applied to the data (Appendix 1) of exporter market share of Japanese beef imports.

To estimate the unknown transition probabilities,  $P_{ij}$ , an error term,  $u_t$ , is added and the Markov model is re-written in terms of exporter market shares;

$$M_{jt} = \sum_i^n M_{it-1} P_{ij} + u_t$$

where,

$M_{it-1}$  = the market share of country  $i$  at time  $t-1$ ,

$M_{jt}$  = the market share of country  $j$  at time  $t$ ,

$i = 1, 2, \dots, r$ , and  $j = 1, 2, \dots, r$ .

The appropriate estimates for  $P_{ij}$  minimize the sum of squared errors,  $u_t^2$  in the equation;

$$u_t^2 = (M_{jt} - \sum_i^n M_{it-1} P_{ij})^2,$$

subject to the required constraints;

$$(A) \quad P_{ij} = 1 \quad \text{for all } i, \text{ and}$$

$$(B) \quad 0 \leq P_{ij} \leq 1 \quad \text{for all } i \text{ and } j.$$

The Minos quadratic programming algorithm (Muntagh and Suanders, 1977) is used to derive the estimates for  $P_{ij}$ . Minos provides for the use of both equality and inequality constraints, so the appropriate constraints (A) and (B) are applied. A systems r-square is calculated as a proxy to the fit the estimates provide.

Comparison of Beef Prices. A paired t-test (Snedecor and Cochran, 1980) is used to determine whether or not Japan paid different prices for beef to its different beef suppliers over the period 1960 to 1985. The t-statistic for a paired t-test is given as;

$$t = [(X_i - X_j) - (u_i - u_j)]/s_{xi-xj}$$

where,

$X_i$  and  $X_j$  are the mean beef prices Japan paid to country  $i$  and country  $j$ , respectively,

$(u_i - u_j)$  = the hypothesized difference between the price paid to country  $i$  and the price paid to country  $j$ , and

$s_{xi-xj}$  = the calculated sample estimate for the standard error of the difference  $(X_i - X_j)$ .

As a first step toward the calculation of a t-statistic, the mean and standard deviation of annual beef prices are calculated for each of the four suppliers: Australia, New Zealand, United States and the ROW. The data used for these calculation details annual average beef price data for each supplier

from 1960 to 1985 (Appendix 3). For calculation of the t-statistic,  $(u_i - u_j)$  is set equal to zero for all  $i$  and  $j$ . This is consistent with the hypothesis that no difference exists between the beef prices paid to any two of Japan's beef suppliers. Consequently, if the t-statistic is sufficiently large the hypothesis of no price difference can be rejected with a known degree of confidence. A t-statistic is calculated for each of the six possible pairs of Japan's major four beef suppliers. The t-statistic has  $2(n-1)$  degrees of freedom.

## RESULTS AND DISCUSSION

Japan is one of the major beef importing nations in the world. Results presented in Tables R1 and R2 summarize Japanese beef importing behavior from 1960 to 1985. Diagonal elements ( $P_{iis}$ ) of the transition probability matrices represent Japan's loyalty toward its individual beef suppliers. Loyalty is the greatest where the  $P_{ii}$ 's are large and close to one. A high degree of buyer loyalty indicates that the probability of repeat purchases are high. Diagonal transition probabilities quantify the portion of an exporter's market share during a given year which was derived from the market share held by the same exporter the previous year. From Table R1, 99.2 percent of Australia's market share in beef quantity in a given year originated from Australian's own market share holding during the previous year. Only 79.2 percent of New Zealand's market share comes from that country's share the previous year. Similar results are illustrated in Table R2 for Japanese beef import values.

Off-diagonal elements ( $P_{ijs}$ ) of the transition probability matrices quantify the portion of country  $j$ 's share which originates from a portion of country  $i$ 's share from the previous year. For example, from Table R1, 1.7 percent of Australia's market share in a given year comes from a part of the United States' market share in the previous year. Additionally, 0.8 percent of the United States current market share came from part of the market share New Zealand held the previous year.

If  $P_{ij} = P_{ji}$ , imported beef from countries  $i$  and  $j$  is highly substitutable and competition is great between the two exporting countries.

Neither country i or country j will increase its own share at the expense of its competitor, because annual losses and gains in market share between the two countries are exactly offsetting. Country j

TABLE R1: Transition Probabilities for Exporter Market Share of Japanese Beef Imports in Quantity (1960 - 1985).

	U.S.	AUS.	N.Z.	ROW	
U.S.	.983	.017	0	0	system r-square = .712
AUS.	0	.992	.008	0	
N.Z.	.020	.009	.792	.179	
ROW	.015	0	.026	.959	

TABLE R2: Transition Probabilities for Exporter Market Share of Japanese Beef Imports in Value (1960 - 1985).

	U.S.	AUS.	N.Z.	ROW	
U.S.	.976	.024	0	0	system r-square = .695
AUS.	0	.989	.011	0	
N.Z.	.043	.003	.786	.168	
ROW	.017	0	.073	.910	

gains in market share at the expense of country  $i$  when  $P_{ij} > P_{ji}$ , because country  $j$ 's annual losses in market share to country  $i$  are not offset by the annual share which country  $j$  takes from country  $i$ . Importer bias may cause a difference in  $P_{ij}$  and  $P_{ji}$ , and such a bias reduces competition between the exporting countries.

Telser (1964) indicated that transition probabilities are a function of relative prices, product quality and promotion. Additionally, political and institutional relationships between exporter and importer will also influence transition probabilities. A buyer will favor imports from a country maintaining low relative prices and acceptable quality. However, political and institutional factors, which often culminate in bilateral agreements, produce directional forces in the market. These forces may work in the same direction or opposite to price and quality factors, and, as a result, the market position of an individual exporter may improve or deteriorate.

To determine the degree of loyalty which Japan holds for each of its beef suppliers, diagonal elements of the transition probability matrices can be compared to similar estimates made by Wilson et al. (1986) and Dent (1967). For Japanese beef imports, both quantity and value,  $P_{11}$ ,  $P_{22}$  and  $P_{44}$  are greater than 0.90. In analyzing buyer behavior for an aggregate of major wheat importers, Wilson et al. noted that the largest estimated  $P_{ii}$  value was 0.96. Among individual wheat importers the largest  $P_{ii}$  value was 0.72, while remaining diagonal transition probability estimates ranged from 0.68 to 0.19. Wilson et al. considered any estimate above 0.60 as an indicator of strong buyer

loyalty. Dent's analysis of international wool flows produced  $P_{ij}$  values which ranged from zero to 0.96. Transition probabilities were estimated for seven major wool importing nations, and five of 42  $P_{ij}$  estimates were greater than 0.70.

Withstanding the lack of other studies for comparison, there is little doubt that the  $P_{ij}$ 's for Japanese beef imports indicate that the Japanese are loyal to Australia and the United States as foreign beef suppliers. Australia and the United States are the two largest shareholders in the Japanese imported beef market, and both countries appear to have a very strong hold on the market. Interpretation of the diagonal estimate corresponding to the ROW is more difficult due to its undefined identity. Japan is committed to the continued patronage of beef exporting countries other than Australia, New Zealand and the United States, but only in relatively small amounts.

Japan is less loyal to New Zealand as a foreign beef supplier ( $P_{33} = .79$  for both quantity and value). New Zealand's share of Japanese beef imports declined substantially over the evaluated period, 1960 to 1985 (Appendix 4). However, rapid growth in Japanese beef imports allowed New Zealand's volume of beef exports to increase slightly despite its rapid loss of market share. Though New Zealand has not been sought as a major beef Japanese beef supplier in recent years, Japan continues to demonstrate a fairly strong degree of loyalty to this country.

Figure D1 illustrates the dominant trade flow directions among Japan's beef suppliers. Examination of the off diagonal transition probabilities provides information for the figure. Each of Japan's

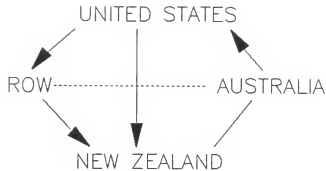


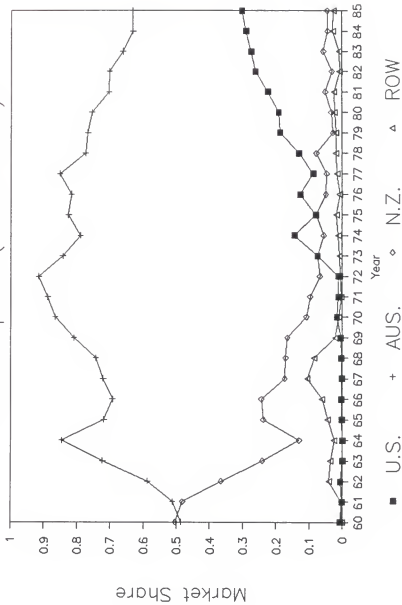
Figure D1: Net Market Share Flows Among Japan's Foreign Beef Suppliers.

suppliers are paired. The arrow between each pair of suppliers has been directed toward the country which annually receives a larger portion of its market share from the nation with which it is paired than it gave up to that same nation. A solid line is used to illustrate even trade flows between Australia and New Zealand, because neither country had a net gain in market share from the other country. The dotted line between Australia and the ROW indicates that trade did not flow in either direction between the two countries.

Figure D1 can be compared to the graph of the market shares of all four Japanese beef suppliers from 1960 to 1985 (Figure D2). There is considerable agreement between these two illustrations, but several discrepancies also exist. Figure D1 shows Japanese beef trade flowing to New Zealand from the United States. Such movement is not apparent on the market share graph. Prior to 1972, New Zealand's market share decreases, and the United States share remains negligible. After 1972,



Figure D2: Exporter Market Share of Japanese Beef Imports (1960-1985).



New Zealand's share continues to decline, while the United States share increases rapidly.

Transition probability estimates in Figure R1 and R2 indicate that trade flows from the ROW to New Zealand occurred during the evaluation period. Trade flows in this direction are not apparent in Figure D2. From 1960 to 1967, New Zealand's market share falls while the ROW's share increases. After 1967, New Zealand's share declines further, but the ROW's share does not increase appreciably.

The lack of trade flow between Australia and the ROW as indicated in Figure D1 is also seen in the market share graph. The market shares of Australia and the ROW essentially trend together throughout the 25 year evaluation period. Both countries' market shares showed mostly increases during the 1960s, then remained constant or declined during the 1970s and early 1980s. Australia did lose a substantial portion of its market share after 1972, but the ROW did not obtain any of Australia's loss.

The market share graph is less clear in illustrating trade flows from the United States to the ROW. Any trade flow between these two suppliers has been minute as indicated by the magnitude of the transition probabilities  $P_{14}$  and  $P_{41}$  in Tables R1 and R2. During the 1970s and 1980s, the United States share was growing rapidly, but very little of this increase could have come from ROW share losses, because the ROW share averaged less than two percent of the total market during the period.

Figure D1 indicates that transition probabilities which describe market share flows between New Zealand and Australia are almost exactly

offsetting (near pairwise-symmetry exists between  $P_{23}$  and  $P_{32}$  in both Table R1 and Table R2). In a given year, New Zealand will likely obtain exactly the same portion of its market share from Australia that Australia will obtain from New Zealand. This offsetting exchange which results in a zero net flow of market share apparently disagrees with the market share graph. Clearly, from 1960 to 1964 and from 1969 to 1972, Australia gained substantial market share at the expense of New Zealand. From 1972 onward, the market shares of both countries trend downward. Hence, it is unclear where New Zealand makes gains at Australia's expense to offset its earlier losses to Australia. A possible explanation is the two year rebound in market share New Zealand made during 1965 and 1966. This rebound came almost solely from losses in the Australian share.

Market shares trade flows between the United States and Australia from Figure D1 are easy to reconcile with the market share graph. The estimated transition probabilities depict a net flow in market share from the Australia to the United States. In viewing the market share graph, the occurrence of such trade flows are readily apparent after 1972. During the years when Australia's share of Japanese beef imports grew dramatically (1960 to 1972), the United States held too small a share to contribute to Australian increases. From 1972 to 1985, the United States share has grown substantially, and particularly after 1978, growth in the United States share has come almost entirely at the expense of Australia.

Estimated transition probabilities for exporter market share of Japanese beef imports from 1975 through 1985 (Table R3 and R4)

TABLE R3: Transition Probabilities for Exporter Market  
Share of Japanese Beef Imports in Quantity  
(1975 - 1985).

	U.S.	AUS.	N.Z.	ROW
U.S.	.94	.04	0.2	0
AUS.	0	.97	.03	0
N.Z.	0	.04	0	.96
ROW	.008	0	0	.992

TABLE R4: Transition Probabilities for Exporter Market  
Share of Japanese Beef Imports in Value.  
(1975 - 1985).

	U.S.	AUS.	N.Z.	ROW
U.S.	.815	.085	0	0
AUS.	.02	.98	0	0
N.Z.	.024	.033	.162	.781
ROW	.001	0	0	.998

generally agree with transition probabilities estimated for the entire 1960 to 1985 period (Table R1 and R2). Japan's loyalty toward Australia, the United States and ROW was strong during the 1975 to 1985 period. However, Japanese loyalty to New Zealand has decreased since

the 1960s and early 1970s. Tables R3 and R4 show that a large portion of New Zealand's annual share of Japan's beef imports was obtained from ROW share holdings the previous year.

Transition probabilities from the shortened evaluation period show net share flows from Australia to the United States, from the United States to the ROW (though small) and from the United States to New Zealand (value share only). These net share movements agree with those seen in Tables R1 and R2. Transition probabilities from the shortened period also show no share movement in either direction between Australia and the ROW, which agrees with estimates from the full length evaluation period.

As expected, transition probability estimates from the 1975 through 1985 period show a larger net share movement from Australia to the United States. This agrees with the market share graph (Figure D2) which shows the United States' share of Japanese beef imports rising rapidly during the late 1970s and 1980s, while Australia's share fell substantially. This time period coincides with both the 1978 and 1984 United States - Japan bilateral beef trade agreements which effectively biased the Japanese beef import market toward high-quality beef. The United States clearly increased its market share greatly during this period and some of this increase must be attributed to changes in the political-economic relationship between the United States and Japan.

Beef Price Comparison. Results from the beef price comparison among Japan's foreign beef suppliers support the authors hypothesis that the Japanese view United States beef as distinct from the beef imported

from Australia and New Zealand (Tables R5 and R6). The mean beef price paid for United States beef from 1960 to 1985 was 917,500 yen per kilogram, while beef prices paid to Australia and New Zealand during the same period averaged 445,000 yen per kilogram and 480,800 yen per kilogram, respectively. The United States mean price is significantly different from both the Australian beef price ( $p < .115$ ) and the New Zealand beef price ( $p < .144$ ). Thus, a statement concerning the existence of a price difference between both the United States and Australia and the United States and New Zealand can be made with greater than 85 percent confidence. This price difference coupled with the difference in quality (marbling) between United States beef exported to Japan and beef from Australia and New Zealand, indicates that beef imported from the United States is not a close substitute for beef from either Australia or New Zealand in the Japanese market. Further evidence to support this view is found in the fact that the market for domestically produced beef in Japan is highly segmented, with the quantity of marbling present in the beef as the primary determinant in this segmentation (Mori, 1986).

The smallest difference in mean imported beef prices among Japan's beef suppliers is the price difference found between Australia and New Zealand. This difference is not significant ( $p > .25$ ), so Japan essentially pays the same price for beef imported from these two suppliers. Beef from Australia is apparently quite similar in quality to beef from New Zealand, and the two are viewed as near perfect substitutes in the Japanese market. The previously discussed pairwise symmetry exhibited in the market share transition probabilities for

Table R5. Mean Annual Beef Price Received by Japan's Major Beef Suppliers over the Period 1960 to 1985.

Beef Supplier	Mean Beef Price (1000 yen/metric ton)
United States	917.5
Australia	445.0
New Zealand	480.8
ROW	610.0

Table R6. Statistical Results from a Comparison of Mean Beef Prices Among Japan's Major Beef Suppliers.

Suppliers Compared	t-statistic	Probability that $H_0$ is true <sup>1</sup>
U.S. - AUS.	1.231	< .115
U.S. - N.Z.	1.101	< .144
U.S. - ROW	.851	< .200
AUS. - N.Z.	-.327	> .250
AUS. - ROW	-.618	> .250
N.Z. - ROW	-.436	> .250

1. The hypothesis of zero price difference is designated  $H_0$ .

Australia and New Zealand also indicate that imported beef from these two countries are readily substituted.

It is less clear how beef from the ROW is perceived in Japan. The mean price of beef paid to the ROW for the evaluated period was 610,000 yen per kilogram. A price not significantly different from the mean beef price of any of the other three suppliers. This result may be due to the composition of the ROW, which is made up of several suppliers exporting different qualities of beef.

Interpretation of both transition probability results and mean price differences is essential in assessing the overall competitiveness of the Japanese market for imported beef. Commodity differences and the lack of substitutability between the United States and Australia (Japan's two major beef suppliers) tend to greatly reduce the competitiveness of Japanese beef markets. Though the primary product (a beef calf) is the same for both suppliers, each suppliers eventual transformation of the primary product results in the production of different end products for export. The transformation essentially decides whether the final exported product will fall into either the "fed" or "nonfed" beef market in Japan. Natural resources and historical production methods undoubtedly influence the path of product transformation in both Australia and the United States. The United States, with inexpensive and abundant grain supplies coupled with a highly capitalized cattle feeding industry is likely to continue producing "fed" beef for export. In contrast, Australia with smaller grain supplies and abundant rangeland will be apt to export almost entirely "nonfed" beef.

Beef imported from both countries is subject to Japan's general beef quota. Australian beef and United States beef do compete to fill this



annual quota. However, beef from the United States is also subject to a high quality beef agreement which represents a fixed portion of the general quota. The United States essentially has no competition for the filling of the high quality beef agreement. As mentioned, Japan has expanded the high quality beef quota at a faster rate than the general quota has been expanded. In doing this the Japanese have essentially biased the market toward the United States. Such action may be a response to political pressure the United States has placed on Japan to increase agricultural imports from the United States. Japan seems inclined to respond to pressure of this type, because United States markets are extremely important to Japanese industrial exports. Australia is a less important source of export revenue for Japan. It is apparently more beneficial for the Japanese government to take actions which quiet the political cries of the United States, than to expand its general beef quota at a rate that would allow Australia to compete evenly with the United States.

Strong competition could potentially exist between Australia and New Zealand. Beef exported from New Zealand readily substitutes for Australian beef in the Japanese market. However, Australia holds a much larger share of Japanese beef imports, and receives a greater degree of loyalty from the importer. New Zealand has adequate production and export volumes of beef to be a major Japanese supplier. Yet, in recent years, New Zealand can only be considered as a minor source of imported beef to Japan. Australia's dominance in the market makes it doubtful that competition between these two countries is as strong as the highly substitutable beef products from these countries would

indicate.

Only weak competition between New Zealand and the United States exists in the Japanese market for imported beef. Beef imported from New Zealand does not readily substitute for beef imported from the United States. Like Australia, New Zealand has virtually no access to the volume of allowable imports within the high quality beef quota. Japan is more loyal to the United States as a beef supplier, and this has undoubtedly enabled the United States to increase its market share at New Zealand's expense.

The amount of competition which exists between the ROW and Japan's three other beef suppliers is difficult to assess. There is apparently some substitutability between ROW beef and beef from each of the other important suppliers. However, the ROW holds only a very small share of Japanese beef imports, and it is doubtful that any single nation within the ROW can seriously compete with Australia, New Zealand and the United States for Japanese beef imports.

## CONCLUSIONS

Japan is a major importer in the world beef market. Australia and the United States are Japan's major beef suppliers. New Zealand is a minor beef supplier to Japan. All other beef exporting nations combined hold a very small share of Japan's beef import market. The Japanese are extremely loyal to Australia and the United States as suppliers of foreign beef. Importer loyalty of this type manifests in a high probability of repeat purchases from the same supplier. Japan is loyal to New Zealand as a minor beef source. However, supplier loyalty toward New Zealand is not as strong as loyalty to either Australia or the United States, and has decreased in the past decade.

Japan pays a higher price for "fed" beef from the United States than for "nonfed" beef from either Australia or New Zealand. In the Japanese market, beef imported from the United States is essentially viewed as a different commodity than beef imported from either Australia or New Zealand. As a result, United States beef does not substitute well with Oceanic beef. Australian beef and New Zealand beef are viewed as close substitutes in Japanese market.

Only a weak degree of competition exists among Japan's foreign beef suppliers. A lack of substitutability between beef from Japan's major beef suppliers greatly reduces competition in the market. The United States is virtually guaranteed the quantity allowed in the high-quality (highly-marbled) beef agreement, because Australia and New Zealand's exports are almost entirely low-quality (lowly-marbled) beef. Recent expansion of the high-quality beef quota at a faster rate than

expansion of the general quota has biased the market in favor of high-quality beef. Hence, the political-economic relationship between Japan and the United States has fueled the increase in the U.S. share of Japanese beef imports.

Competition between Australia and New Zealand could potentially be strong as indicated by the highly substitutable exports from these countries. However, Japan's extreme loyalty to Australia as a major beef supplier coupled with the fact that New Zealand holds only a minute share of the total market, makes it unlikely that strong competition exists between the two exporters. Beef exporters other than the United States, Australia and New Zealand will have extreme difficulty penetrating the Japanese imported beef market. Substantial increases in market share are unlikely for such countries, because of Japan's extreme loyalty toward its major suppliers.

## ACKNOWLEDGEMENTS

During the past two years spent working on third floor Waters Hall, the author has greatly appreciated the assistance and friendship of many people. A special thanks goes to Dr. Orlen C. Grunewald for serving as my major professor, and to Drs. John B. Sjo and Paul L. Kelley for serving as my graduate committee. The author also appreciated the financial support provided by the Kansas State University International Livestock and Meat Program.

To all my fellow graduate students in agricultural economics and economics, many thanks, you guys kept it fun.

To my special wife, Mindy, thank you for all the love and support given so unselfishly. I love you.

To my family who wholeheartedly supported me through a second masters degree, thanks again.

Most of all I want to thank God for His provision of daily strength and for the greatest act of love in history, which is the cross.

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APPENDIX 1

Exporter Market Share of Japanese Beef  
Imports (Quantity)

Year	U.S.	Aus.	N.Z.	ROW
1960	0.008	0.487	0.504	0.001
1961	0.001	0.512	0.482	0.004
1962	0.006	0.587	0.366	0.04
1963	0	0.723	0.241	0.036
1964	0	0.846	0.13	0.024
1965	0.001	0.719	0.238	0.043
1966	0.003	0.693	0.244	0.061
1967	0.001	0.721	0.173	0.105
1968	0.003	0.743	0.17	0.084
1969	0.005	0.809	0.165	0.021
1970	0.016	0.866	0.108	0.01
1971	0.012	0.889	0.096	0.002
1972	0.011	0.915	0.067	0.007
1973	0.075	0.843	0.074	0.008
1974	0.144	0.79	0.055	0.011
1975	0.079	0.826	0.078	0.017
1976	0.126	0.817	0.049	0.007
1977	0.087	0.852	0.046	0.015
1978	0.129	0.775	0.077	0.018
1979	0.187	0.768	0.027	0.018
1980	0.191	0.755	0.032	0.022
1981	0.223	0.704	0.05	0.023
1982	0.261	0.702	0.03	0.007
1983	0.274	0.662	0.056	0.008
1984	0.29	0.631	0.042	0.027
1985	0.301	0.631	0.044	0.024

Source: "The Livestock Industry Data Book",  
MERC Staff Report No. 6-85, May 1985.

## APPENDIX 2

Exporter Market Share of Japanese Beef  
Imports (Value)

Year	U.S.	Aus.	N.Z.	ROW
1960	0.012	0.503	0.484	0.001
1961	0.003	0.522	0.467	0.008
1962	0.001	0.577	0.33	0.083
1963	0	0.692	0.233	0.075
1964	0	0.84	0.118	0.042
1965	0.002	0.687	0.233	0.079
1966	0.003	0.673	0.209	0.114
1967	0.003	0.648	0.155	0.195
1968	0.014	0.693	0.144	0.149
1969	0.024	0.777	0.164	0.035
1970	0.061	0.81	0.113	0.015
1971	0.036	0.877	0.079	0.008
1972	0.026	0.89	0.061	0.022
1973	0.112	0.815	0.066	0.066
1974	0.191	0.748	0.053	0.008
1975	0.21	0.688	0.083	0.019
1976	0.24	0.698	0.053	0.009
1977	0.159	0.756	0.065	0.02
1978	0.213	0.691	0.075	0.02
1979	0.242	0.71	0.028	0.02
1980	0.248	0.695	0.038	0.019
1981	0.283	0.639	0.056	0.022
1982	0.35	0.61	0.033	0.07
1983	0.326	0.611	0.058	0.005
1984	0.311	0.612	0.053	0.024
1985	0.323	0.623	0.035	0.018

Source: "The Livestock Industry Data Book",  
MERC Staff Report No. 6-85, May 1985.

## APPENDIX 3

Average Annual Price Paid by Japan for  
Imported Beef by Exporting Country from  
1960 to 1985 (1000 yen/metric ton).

Year	U.S.	Aus.	N.Z.	ROW
1960	291	206	192	180
1961	315	209	199	407
1962	288	187	172	388
1963	---	173	175	381
1964	360	211	195	362
1965	720	220	225	423
1966	370	274	241	530
1967	1620	319	316	654
1968	1554	326	295	622
1969	1410	293	303	520
1970	1355	323	362	529
1971	1139	384	321	1215
1972	984	413	388	1397
1973	945	609	559	546
1974	975	694	711	551
1975	1325	415	526	574
1976	1014	453	570	640
1977	799	387	616	585
1978	762	412	449	510
1979	885	632	731	751
1980	1053	746	953	707
1981	913	653	816	684
1982	1071	694	880	811
1983	918	712	795	530
1984	859	693	724	656
1985	1013	932	786	708

Source: "The Livestock Industry Data Book",  
MERC Staff Report No. 6-85, May 1985.

JAPAN'S IMPORTED BEEF MARKET: A CHARACTERIZATION  
OF LOYALTY TOWARD INDIVIDUAL SUPPLIERS AND  
ASSESSMENT OF COMPETITION AMONG SUPPLIERS

by

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B.S., Kansas State University, 1983  
M.S., Kansas State University, 1985

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AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Agricultural Economics

KANSAS STATE UNIVERSITY  
Manhattan, Kansas

1987

Japan is a major participant in the world beef market. In this study, Japan's loyalty toward its individual beef suppliers is measured, imported beef prices are compared between suppliers and competition among suppliers is assessed. An adapted Markov processes market share model is used to develop transition probabilities for Japan's major beef suppliers, Australia, New Zealand, the United States and a fourth supplier, the ROW or "rest of the world". Transition probabilities quantify Japan's loyalty toward individual beef suppliers. Beef prices are compared between all suppliers via a paired t-test.

Results indicate that Japan is extremely loyal to its two largest suppliers, Australia and the United States. Japan is also very loyal to the ROW, however, only a very small share of Japan's total beef purchases come from the ROW. Japanese loyalty toward New Zealand was fairly strong during the 1960s and early 1970s, but loyalty toward this supplier decreased greatly during the late 1970s and 1980s. New Zealand exports more beef to Japan than does the ROW, but New Zealand is still only a minor beef source for Japan.

The Japanese pay a higher price for beef imported from the United States than for beef imported from either Australia or New Zealand. This fact is consistent with highly-marbled beef from the United States being viewed by the Japanese as a different commodity than the lowly-marbled beef from either Australia or New Zealand. No price difference was found between Australian and New Zealand beef, indicating that these two products are viewed as near-homogeneous in the Japanese market. The price for ROW beef was not statistically different from the beef price of any of Japan's other three suppliers,

which may be due to fact that several different countries make up the ROW. Apparently, Japan receives a mix of both highly-marbled and lowly-marbled beef from the ROW.

Only weak competition exists among Japan's imported beef suppliers. Beef from the two largest suppliers, Australia and the United States, are poor substitutes as indicated by perceived commodity differences. Further, Japan's bilateral agreement with the United State concerning high-quality (highly-marbled) beef essentially guarantees that the United States' exports will fill a fixed portion of the general beef quota. Recent expansion of the high-quality beef quota at a faster rate than the general quota has further biased the market in favor of the United States.

Competition between Australia and New Zealand could potentially be strong as indicated by the high substitutability between beef from these two exporters. However, New Zealand holds such a small share od the current Japanese market that it seems doubtful that Australia is challenged to any great extent by New Zealand. Likewise, the ROW plays only a small role in the Japanese imported beef market and provides little competition for either Australia or the United States.