

Measuring the Degree of Market Power among Beef Exporters to Japan

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Abstract: A residual-demand model for beef exporters to Japan is specified to estimate market power. The analysis is disaggregated by beef cut and form. The results indicate U.S. frozen-ribs category enjoys the highest markup of price over marginal cost, while Australia and New Zealand have some market power, which includes five chilled-beef categories.

Introduction

Japan is the largest beef importing country in the world in terms of value and second (behind the U.S.) in terms of volume. In fiscal year 1999, they imported 683 thousand metric tons of beef, slightly more than they imported in fiscal 1998 (Table 1). In 1999, Japan accounted for 13% of world beef import volume and 17% of world beef import value (United Nations). Japanese beef imports grew rapidly through 1995, but since that time they have shown little growth. Japan's continuing financial problems and slow economic growth have affected beef imports.

Nowhere in the world is the quality spectrum (where quality is measured by the degree of marbling) larger than in Japan's beef market, from low-quality grass fed beef to highly marbled Japanese wagyu beef (Hayes and Longworth). The U.S. Meat Export Federation estimates that U.S. choice beef falls about midway in the quality spectrum for the Japanese market. Japanese consumers are very discriminating in their consumption patterns for beef and beef origin is very important to them. There is a clear preference for domestic beef and Japanese consumers prefer and are willing to pay higher prices for chilled beef products (Kerr et al.; Hayes; and Erikson et al.).

Table 1 shows that Japan is an important beef market for Australia and the U.S., accounting for over 300 thousand tons of exports for each country. Australia and the U.S. have traditionally split the Japanese beef import market, each accounting for slightly less than 50% of the volume. In the early 1990s Australia had a larger market share than the U.S., but the U.S. overtook Australia in 1996 and has been the leading supplier since. In fiscal year 1999, the U.S.

held a market share of 48.6% versus 46.0% for Australia (Table 2). These shares vary, though, depending on the form of imports (whether they are chilled or frozen). Australia leads in exportation of chilled beef, while the U.S. leads in exportation of frozen beef. Canada and New Zealand are more important players in the Japanese beef market for frozen products.

The variety and uniqueness of Japanese cooking styles and the relatively high price of beef make the market very dynamic with regard to the distribution of beef cuts imported. Japanese beef imports are almost exclusively in the form of boneless cuts. Carcasses and bone-in cuts account for less than two percent of imports currently. Chilled beef imports for fiscal year 1998 were 56% chuck, clod and round, 20% loins, and 23% ribs (ALIC). Frozen beef imports for fiscal year 1998 were 17% chuck, clod and round, 7% loins, 48% ribs, and 28% other cuts. In recent years, there has been a move toward chilled chucks and rounds away from loins due to stagnant incomes in Japan and continued high prices for imported beef. Table 3 shows Japanese imports of boneless cuts from the four major beef exporting countries for September 1999 through August 2000. Chilled chucks, clods, and rounds account for the most volume, frozen ribs are second, and chilled ribs are third. The U.S. is the leading supplier of each frozen cut, while Australia is the leading supplier of chilled chucks, clods, rounds, and loins.

Despite this rich diversity and intensity of competition among beef cuts, there has been no analytical research which examines this facet of Japanese import patterns. Further, no analytical study has distinguished between chilled and frozen imports. This study investigates the intensity of competitive relationships among beef import suppliers in the Japanese market using data by beef cut and form (chilled versus frozen). Because of the exacting requirements and differentiated nature of beef products in Japan, exporters could have market power. A residual demand model by country for the main four competitors, Australia, the U.S., Canada,

and New Zealand, is specified and estimated. The objective is to estimate the residual demand elasticity that each exporter faces in Japan. The residual demand elasticities will indicate the extent of market power that beef exporters have in the Japanese beef market. The analysis is disaggregated by beef cut, so that the competitive relationships can vary by beef market segment. The results are used to provide insights into pricing and marketing behavior of major beef exporters competing in Japan.

Conceptual Framework

In an imperfectly competitive market, the extent of competition is expressed as the relative markup of price over marginal cost, or the Lerner index. Many studies have attempted to investigate and measure the index of market power in domestic and international markets (Krugman, Baker and Bresnahan, Knetter 1989 and 1993, Barnett et al., Goldberg and Knetter 1997 and 1999, Gil-Pareja, and Glauben and Loy, among others). In practice, it is usually very difficult to calculate the index directly because marginal costs are unknown and the lack of appropriate data hampers the investigation. Goldberg and Knetter (1999) indicate that the use of accounting data as a measure of marginal costs could lead to a seriously biased measure of market power. In antitrust cases, the standard method used to prove market power hinges on the size of the firm's market share: the higher the market share, the higher the degree of monopoly power, *ceteris paribus*. However, a significant market share can also correspond to a situation where price equals marginal cost (total lack of market power) if the demand elasticity tends to infinity, or a situation where a firm with a small market share applies a significant markup over marginal cost through product differentiation. In the context of international markets, data problems are even more serious because exporters face different competitors and different

demand conditions in destination markets.

Bresnahan surveys models of market power estimation that do not need direct estimation of marginal costs. These models are known as models of new empirical industrial organization (NEIO). One of these methods exploits the relationship between market power and the inverse elasticity of residual demand faced by a firm (Baker and Bresnahan). The residual demand elasticity represents the relationship between a firm's price and quantity, taking into consideration the supply of other producers in the market, and this elasticity is considered a measure of market power. In the case of perfect competition where there is no market power, a firm's supply changes will have no effect on the price and the residual demand is perfectly elastic. In case of market power the elasticity is nonzero, and the steeper the residual demand curve the more market power exists.

Specifically, consider exporter i selling a product in a destination market. This exporter's inverse residual demand depends on the quantities it exports, Q_i , the exports of competitors, Q_j for $i \neq j$, and a vector of destination market demand shifters, Z . The profit maximization problem for exporter i can be written as:

$$(1) \quad \text{Maximize } \pi_i = P_i(Q_i, Q_j, Z)Q_i - e_i C_i(Q_i, W_i)$$

where P_i is the destination market price of product i , e_i is the bilateral exchange rate between the destination market and exporter's currency, and C_i represents exporter i 's costs. Assuming that π_i satisfies sufficient conditions for differentiability, the first order condition for profit maximization is to set the expected marginal revenue equal to marginal cost, or:

$$(2) \quad P_i + Q_i[\partial P_i / \partial Q_i + (\partial P_i / \partial Q_j)(\partial Q_j / \partial Q_i)] - e_i MC_i = 0, \forall i \neq j.$$

Here the terms in the bracket represent the conduct parameters of exporter i faced with other competitors and the strategic interactions of the exporters in the market. In the case of perfect

competition, the terms in the bracket are zero and price equals marginal cost in the market. The estimation of a simultaneous system made up of the above inverse demand relationships and the corresponding first order conditions provide a measure of market power as well as complete information about own and cross price elasticities and conduct (Bresnahan).

A method developed by Goldberg and Knetter (1999) manipulates the above simultaneous system to obtain only one equation for estimation of the exporter's residual demand, which is a reduced form version of the above structural model. The exporter's market power is captured through the elasticity of this residual demand equation. The variables in this inverse residual demand include quantity exported, a vector of demand determinants in the destination market, and competitors' cost shifters. The clear advantage of this method is that it requires far less detailed data, which are generally lacking in domestic and international markets, in order to estimate a measure of market power.

The explicit expression of the inverse residual demand function developed by Goldberg and Knetter (1999) for an exporter is:

$$(3) \quad \ln p_{mt}^{ex} = \lambda_m + \eta_m \ln \hat{Q}_{mt}^{ex} + \alpha'_m \ln Z_{mt} + \beta' \ln W_{mt}^N + \varepsilon_{mt}$$

where m denotes a specific destination market and N denotes the number of competitors an exporter faces in that market. In this specification, export unit prices and demand shifters are expressed in units of the destination currency. The equations are expressed in double-log form so that the coefficients are interpreted as elasticities and the error term is assumed to be independent and identically distributed. Since the quantity exported is simultaneously determined along with the export price, it is endogenous and needs to be instrumented. Tests for endogeneity should be conducted. An exporter's supply shifters and the bilateral exchange rate between the exporting country and the destination market are natural instruments.

The coefficient on quantity exported represents the inverse of the residual demand elasticity, which is the main point of interest here. If it is estimated to be zero, it indicates competitive behavior and a lack of market power. If it is statistically significant, it means there is market power and a larger value is an indication of relatively more market power over price. Baker and Bresnahan and Goldberg and Knetter (1999) argue that in some cases this residual demand elasticity coincides with the measure of markup over marginal costs, known as the Lerner index. Those cases are the Stackelberg leader, the dominant firm model with a competitive fringe, and the case in which extensive product differentiation is present.

The latter case is of special interest in this research because imported beef is differentiated in Japan and the quality and retail prices of beef by country of origin vary widely in the Japanese beef market (Longworth). Survey results have also shown that Japanese consumers have strong preferences for quality in beef and can readily identify different qualities of beef in the market (Khan, Ramaswami, and Sapp). Goldberg and Knetter (1999) argue that: “in the case of product differentiation, the distinction between conjectural variations and reaction functions becomes less relevant as the substitutability between the products of competing firms diminishes. Intuitively, if a firm has market power because its products are distinct from the products of other firms, the role of strategic interaction is less important” (p. 39).

Empirical Model and Data

For this research, it is assumed that each exporting country faces a residual demand curve that is downward sloping, reflecting the market demand minus the supplies of competitors. The country can maximize profit from that residual demand curve through its output decisions¹. Beef is assumed to be differentiated by country of origin. For instance, Australian beef is differentiated

from U.S. beef. Also, the beef market is segmented by beef types (chuck, loin, and ribs) and each cut is separately analyzed on a chilled and frozen basis. The choice of beef cuts in this research is strictly determined by data availability. The beef type chuck includes chuck, clod, and round.

In this specification, the demand shifters include a time trend, real disposable income, and the price level in the destination market. The competitors' cost shifters usually include typical input prices such as wages and prices of raw materials. However, Goldberg and Knetter (1999) suggest that detailed costs shifters of competitors are not necessary in the international setting and bilateral exchange rates can be used as ideal cost shifters because exchange rate variations shift the costs of exporters in the destination market. Hence, in the case of the four main beef exporters to Japan, four equations are specified and estimated separately for each of the three beef types in chilled and frozen forms as follows:

$$(4) \quad \ln P_{t,k}^i = \lambda_k + \eta_k \ln \hat{Q}_{t,k}^i + \alpha_k T_t + \beta_k \ln(DY_t / CPI_t) + \sum_{j \neq i} \delta_k^j \ln e_{t,k}^j + \varepsilon_{t,k}$$

where t and k index time and beef type, respectively, i and j index countries, T denotes time trend, e is the bilateral exchange rate, and DY stands for Japanese nominal disposable income. The endogenous variables are the unit export prices in the destination market currency, yen per kilogram.

The model is fitted using monthly data from February 1992 to August 2000. Monthly data allows for higher frequency and more observations to investigate the relationships existing among the variables in the model. The data are disaggregated by beef cut to capture the differences in the market segments. Data on Japanese prices and imports by cut came from the Agriculture and Livestock Industries Corporation (ALIC). Exchange rates came from the International Monetary Fund. Japanese personal consumption expenditures were used as the measure of income. Expenditure data were chosen because they were readily available on a

quarterly basis. These quarterly data were divided by three to obtain monthly estimates. Expenditure data came from the Economic Planning Agency of Japan.

Estimation Results

Equation (4) is estimated for each beef type separately; we have treated the four country equations of each beef type as a separate simultaneous system using the Iterative Seemingly Unrelated Regression. Hence, there is a simultaneous system for each beef type (chuck, loin, and ribs) and form (fresh and frozen). Each simultaneous system has four equations, one for each of the four competitors in the Japanese beef market: the U.S., Australia, Canada, and New Zealand. Overall, there are 24 equations, one for each beef type for each country and, accordingly, 24 residual (inverse) demand elasticities. The time series nature of the data set suggests that autocorrelation could be a problem. We tested for autocorrelation and performed the appropriate transformations when the tests indicated its presence. One should remember that if the market is perfectly competitive, the residual demand elasticities will equal zero; otherwise the market is imperfectly competitive. Table 4 summarizes the estimation results for the residual inverse demand elasticities.

In over one half of the cases (13 of 24), the elasticity estimates were significantly different from zero, showing some degree of imperfect competition. All the statistically significant residual inverse demand elasticities had the expected negative sign, indicating that the exporting countries face a negatively sloped residual demand curve.

U.S. exports of chilled and frozen chuck, loin, and ribs:

The estimated residual inverse demand elasticity of U.S. frozen ribs, which is significantly

different from zero at the one-percent level, approximates the markup of price over marginal cost or Lerner index. Its estimated value in absolute term is 3.1 ($=1/0.3223$) and it is the sole demand elasticity that is statistically significant among the six U.S. beef types exported to Japan. This implies that though the U.S. has a significant market share in the Japanese beef market, the conjecture of competitive behavior can only be rejected in the frozen ribs market. U.S. exporters behave competitively and do not apply any market power in their sales of chilled beef (chuck, loin, and ribs) and frozen chuck and loin in our sample.

The estimated elasticity for U.S. frozen ribs is relatively elastic, and its value indicates that the U.S. market power for frozen ribs is the largest among all beef-types exported to Japan. Frozen ribs are used in the “beef bowl” restaurants, which are sometimes labeled as Japanese fast food, and U.S. frozen ribs dominate as the raw ingredient for this market. This relatively high residual demand elasticity for U.S. frozen ribs is plausible and consistent with the high Japanese consumer demand and the rapidly expanding market for this product.

Despite having a significant market share with some other beef types, the U.S. does not have significant market power. These results are likely because most of the U.S. beef cuts that are exported to Japan are not used extensively in the U.S. In fact, correspondence with the U.S. Meat Export Federation reveals that most of these beef cuts would be trim (used as ground beef) if they remained in the U.S. In that sense, the Japanese buyers do a big favor to U.S. packers by taking what would otherwise be low-value cuts in the U.S., and marketing them as higher-valued cuts in Japan. Hence it is reasonable that U.S. packers would not apply market power when it comes to such products.

Frozen ribs might be an exception because the “beef bowl” restaurants are so popular in Japan. Japanese buyers must bid away some rib cuts from the U.S. market so that their desire for

these meal types are satisfied. This gives the U.S. sellers some degree of market power and allows them to sell above marginal costs.

Australian exports of chilled and frozen chuck, loin, and ribs:

Australia, like the U.S., has a major market share in the Japanese beef market. The empirical results for the residual inverse demand elasticity of Australian beef exports to Japan indicate that the hypothesis that Australian exporters face a perfectly elastic residual demand is rejected in five of the six beef categories. The one estimated residual demand elasticity that is statistically insignificant is chilled chuck, indicating no markup over marginal cost. The estimated inverse demand elasticities that are significantly different from zero range from -0.09 for fresh and chilled ribs to -0.12 for fresh and chilled loin in our sample, indicating residual demand elasticities of 8 to 11 ($=1/0.12$ to $1/0.09$) in absolute value. Hence, the residual demands for Australian beef categories are highly elastic and the markups are relatively small.

The Japanese market is very important to the Australian beef industry, but the reverse is also true. Despite being heavily reliant on the Japanese beef consumers, the Australians have been able to take advantage of their product's relatively low price to extract some profits through their exportation for most cuts.

Canadian exports of chilled and frozen chuck, loin, and ribs:

The empirical results for Canadian exports show that estimated residual inverse demand elasticities are significantly different from zero for two beef categories, chilled loin and frozen ribs; and the estimated values are -0.1032 and -0.1710, respectively. Given that Canada also exports grain-fed beef to Japan, one would expect their results to be similar to the U.S. This was

the case. Since the beef industry is smaller in Canada than in the U.S., it makes perfect sense that Canadian exporters might be able to sell above marginal costs for frozen ribs (as the U.S. did) and chilled loins too. Because Canada's supplies are more limited, demand pressure from the Japanese can play a larger role in influencing Canada's price for some cuts.

New Zealand exports of chilled and frozen chuck, loin, and ribs:

New Zealand, like Canada, has a small share of the Japanese beef import market, yet the estimated residual inverse demand elasticities of five beef categories are highly statistically different from zero, rejecting the hypothesis of perfect competition in our sample. The one beef type in which the hypothesis of perfectly competitive behavior cannot be rejected is for frozen loin. The estimated residual inverse demand elasticities range from -0.15 to -0.19 showing, in general, small application of market power with relatively elastic residual demands. Therefore, one can conclude that considering the residual inverse demand elasticity as a measure of markup over marginal cost, New Zealand beef exporters apply some market power in Japanese beef market, though their market share is small.

Summary and Conclusions

In this article, we investigate the intensity of competitive relationships among beef exporters in the Japanese market using disaggregated data by beef cut. The analysis is disaggregated by beef cut, so that the competitive relationships can capture the variation by beef market segment. Because of the exacting requirements and differentiated nature of beef products in Japan, exporters could have market power. A residual demand model for the main four competitors, Australia, the U.S., Canada, and New Zealand, is specified and estimated. The objective is to

estimate the residual demand elasticity that each exporter faces in Japan. The residual demand elasticities indicate the extent of market power beef exporters have in the Japanese beef market.

Overall, the results of this analysis lend interesting insights into the competitive behavior of beef exporting countries in the Japanese market. The import patterns are clearly quite different by country, cut, and form, requiring an analysis that is more disaggregated than in previous studies. The estimated results indicate clearly that the highest markup of price over marginal cost belongs to U.S. frozen ribs, and this is the only indication of market power by U.S. exporters. The fact that most U.S. beef cuts to Japan have a very limited market in the U.S. is illustrated in this analysis. Because these cuts have a low value in the U.S. there is less room for U.S. exporters to price above marginal cost.

Australia, with a very significant market share, and New Zealand, with a relatively small market share, both enjoy some degree of market power. Despite relying heavily on the Japanese market as an outlet for their products, exporters in Australia and New Zealand are able to take advantage of the low price and freshness of their products by capturing some small profits in exportation. The closer proximity of Australia and New Zealand to the Japanese market allows them to enjoy lower transportation costs and more rapid deliveries. This gives them an advantage, especially in the chilled beef market.

Japanese consumers show strong preferences for freshness and these preferences contribute to a wider markup of prices for Australian and New Zealand exporters. These results are consistent with previous studies of Japanese meat market. A U.S Meat Export Federation survey found beef freshness was one of the most important product attributes to Japanese beef consumers. This survey showed Japanese meat consumers' decision to purchase beef was strongly influenced by beef freshness, in contrast to price, product safety, and cleanliness (Kerr

et al. and Hayes). In another study, production date was found as a significant factor for Japanese steak consumers. Increasing the importance of freshness, indicated by the date of expiration, by one unit increased the probability of buying steak by 6.27 percent (Erikson, et al.). Australia and New Zealand can get beef into Japan with a longer shelf life, which puts U.S. and Canadian beef exporters at a clear disadvantage. Transportation technology now allows the U.S. to ship chilled beef to Japan by sea, but shelf life relative to beef from Australia is still an issue.

The results provide many insights into the behavior of beef exporters in the Japanese market. It is clear that exporting countries face downward-sloping residual demand functions for some of the chilled and frozen cuts, especially for Australia and New Zealand. The U.S. and Canada, with large and small market shares, respectively, both behave competitively for most beef cuts. Out of the thirteen estimated residual inverse demand elasticities that were significantly different from zero, ten are associated with Australia and New Zealand (five for each country) and only three are associated with the U.S. and Canada. Australia, generally a non-fed supplier, exports beef that has relatively low inverse demand elasticities. The demand faced by New Zealand exporters, another non-fed supplier, indicates successful niche marketing. Demand patterns are not substantially different between chilled and frozen or by cuts except for the U.S. frozen ribs. The own price inverse elasticity is larger in absolute value for U.S. frozen ribs, where the U.S. dominates, than any other beef type.

American exporters generally seem to pay less attention to markup pricing over marginal costs than Australian exporters. This is understandable if the U.S. product does not have a high-valued market in the U.S., but does in Japan. In this case, the Japanese simply need to offer a price slightly above the beef's use as trim in order to bid it away from the U.S. market. Unless Japanese buyers bid the product away from higher valued uses in the U.S., the Japanese hold all

the market power.

The results have implications for advertising and promotion by beef exporting countries. Promotion efforts by Australia and New Zealand have clearly differentiated their product and generated market power for those exporters for certain beef cuts. The U.S. and Canada don't have such power except for beef ribs. Other studies (Comaeu et al. and Le et al.) have found that advertising and promotion efforts for imported beef significantly strengthen Japanese demand for beef. However, they studied aggregate beef exports and did not analyze the effects by beef cut or form. The U.S. and Canada should consider increased promotional expenditures which address specific cuts, rather than generic beef, to enhance exports.

There is definitely a need for further research in this area because of the new insights brought with this model. Different, more structured competitive behavior could be hypothesized and imposed with supply and demand relationships. This would provide more rigorous testing of specific hypotheses on pricing and reaction relationships. Another avenue might be to investigate the Japanese beef market hypothesizing imperfectly competitive buyers. Japanese trading companies still dominate the import process – for instance, they have title to U.S. beef as it goes through customs. They might be extracting rents from export suppliers.

Footnote

¹ Treating countries as exporters is an abstraction from reality. We are forced to use country data to test the hypothesis of market power due to lack of firm level data. In such cases, the estimated parameters may be interpreted as industry averages.

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Table 1. Japanese Beef Imports (in thousand metric tons), Fiscal Year 1999 (April 1 - March 31)

	<u>Chilled</u>	<u>Frozen</u>	<u>Total</u>
Australia	192.1	121.5	314.1
US	136.6	194.8	331.6
Canada	3.9	14.5	18.4
New Zealand	<u>3.5</u>	<u>10.4</u>	<u>14.0</u>
Total	336.2	345.2	682.6

Table 2. Share of Japanese Beef Import Market, Fiscal Year 1999, in Percentages

	<u>Chilled</u>	<u>Frozen</u>	<u>Total</u>
Australia	57.1	35.2	46.0
US	40.6	56.4	48.6
Canada	1.2	4.2	2.7
New Zealand	<u>1.0</u>	<u>3.0</u>	<u>2.0</u>
Total	49.2	50.8	100.0

Table 3. Japanese Imports of Boneless Beef Cuts (in metric tons) for the Period 1999:09-2000:08

	<u>U.S.</u>	<u>Australia</u>	<u>Canada</u>	<u>N Zealand</u>	<u>Total of 4</u>
Chilled Chucks ^a	65,488	125,964	1,799	2,227	195,478
Chilled Loins	25,837	37,807	641	575	64,860
Chilled Ribs	51,549	33,199	2,540	598	87,886
Frozen Chucks	26,744	20,155	530	3,442	50,871
Frozen Loins	11,662	7,200	875	2,156	21,893
Frozen Ribs	<u>148,184</u>	<u>10,978</u>	<u>11,718</u>	<u>1,634</u>	<u>172,514</u>
Total	329,464	235,303	18,103	10,632	593,502

^a Chuck refers to chuck, clod, and round.

Table 4. Estimated Residual Inverse Demand Elasticities in Japanese Beef Market^a

	Australia	Canada	New Zealand	United States
Chilled:				
Chuck ^b	-0.1172 (-0.2464) ^c	-0.0079 (-0.2606)	-0.1713 ^{***} (-4.9198)	0.0108 (0.2437)
Loin	-0.1237* (-1.9938)	-0.1032 ^{***} (-3.7836)	-0.2038 ^{***} (-4.7572)	-0.0255 (-0.7299)
Ribs	-0.0926* (-1.6018)	0.0227 (0.0616)	-0.1562 ^{***} (-3.9099)	0.0385 (0.8632)
Frozen:				
Chuck	-0.1151 ^{***} (-3.724)	-0.1951 (-1.1051)	-0.1485 ^{***} (-3.4598)	-0.0416 (-1.327)
Loin	-1.0986 ^{***} (-4.1333)	-0.0100 (-0.1856)	-0.2162 (-1.3872)	0.0130 (0.1049)
Ribs	-0.1170 ^{**} (-2.7298)	-0.1710 ^{**} (-2.5275)	-0.1871 ^{***} (-4.7376)	-0.3223 ^{***} (-4.6250)

Notes: ^a for the period 1992:02-2000:08

^b chuck refers to cuts from chuck, cold, and round

^c t-statistics are in parentheses

^{***} significant at 1% level

^{**} significant at 5% level

^{*} significant at 10% level