Do the Japanese Discriminate Against Australian Beef Imports?: Evidence From the Differential Approach

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Abstract

This paper considers an application of the differential approach to Japanese demand for beef imports from 1970 to 1993. Results of homothetic demand and negative (significant) own-price elasticities indicate that the Japanese did not discriminate against Australian beef, but the decrease in Australia's trade shares was due to changes in relative prices.

Key Words: Japan, beef imports, import demand, differential approach, Rotterdam model, CBS model

Historically, Japan has protected its beef producers from imported beef with various policies such as domestic producer price supports, import quotas, and import tariffs. Before 1970, Japan imported an insignificant portion of the beef it consumed. Although Japan has more than doubled its production of beef over the past 20 years, the demand for beef has increased even more rapidly due to increases in per capita income. By 1990, beef imports contributed to approximately 30 percent of total beef consumption in Japan.

Due to greater Japanese demand for beef, combined with limitations on increasing domestic production and pressure from beef exporting countries, Japan agreed in June 1988 to a six-year plan, the Beef Market Access Agreement (BMAA). This agreement reduced quota restrictions on imported beef and agreed to increase Japanese beef imports by 60,000 metric tons (mt) per year through 1990. The Japanese also agreed to replace the import quota by a temporary 70 percent import tariff in 1991, and to reduce the tariff to 60 percent in 1992 and to 50 percent in 1993. After 1993, any further reductions will be undertaken in the context of the General Agreement on Tariffs and Trade (GATT). However, Japan reserves the right to impose a 25 percent tariff in any year that beef imports increase by 20 percent over the previous year (Coyle 1984 and 1990).

Given these changes in Japan's beef policies, the three major exporters (i.e., Australia, New Zealand, and the U.S.) are concerned about the effects these policies will have on their beef exports to Japan. The Australians have complained that U.S. beef imports have been given favorable treatment by Japan (Coyle and Dyck).[1] Their argument can be supported by looking at the budget shares over time in table 1. Australia's trade shares moved from 79 percent in 1970 to 41 percent in 1993 (column 2), while the U.S.'s trade shares went from 4 to 56 percent (column 4) over the same time period. The U.S. denies these allegations and suggests that Japanese consumers prefer U.S. grainfed beef to the grassfed beef which Australia and New Zealand produce.

The purpose of this paper is to analyze the Japanese import market for beef and determine

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Table 1. Countries Trade Shares and Prices for Imported Beef to Japan, 1970-1993.

	Trade Shares over Time				Beef Prices Over Time[a]				Prices Relative to Australia		
Year	Australia	New Zealand	U.S	Other	Australia	New Zealand	U.S	Other	NWZLD/ AUS[b]	US/ AUS[c]	ROW/ AUS[d]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1970	.79	14	.04	.03	0 90	1.00	3 77	1.47	1.12	4 20	1.63
1971	85	10	.04	01	1.10	1 03	2 53	1 41	0.93	2.30	1.28
1972	90	08	.03	01	1.37	1 26	3 52	1.42	0.93	2.58	1.04
1973	.86	06	.07	01	2 24	2 06	3 48	2.02	0.92	1.55	0.90
1974	.78	.06	.15	.01	2 39	2.44	3.35	1 91	1.03	1.40	0.80
1975	72	.07	20	.01	1 40	1.77	4 46	1 94	1.27	3.19	1 39
1976	70	07	.22	01	1.53	1 92	3.35	2 37	1.26	2.20	1 56
1977	.73	06	.19	01	1.43	2 25	2.94	1 78	1 57	2 05	1.24
1978	.73	07	.19	02	1.96	2.08	3.70	2.44	1.06	1 89	1.25
1979	70	.05	23	.02	1 88	3.44	4 10	3.43	1.19	1.42	1 19
1980	71	.03	.24	.02	2.29	4 26	4.67	3 10	1 29	1.42	0 94
1981	67	.05	.26	.02	2.97	3.68	4 15	3.07	1.24	1.40	1.03
1982	63	.04	31	.01	2 76	3 53	4 24	3.36	1.28	1.54	1.22
1983	.61	.05	.34	.01	2 99	3.33	3 83	2.22	1.11	1.28	0 74
1984	.60	.05	.33	.01	2.92	3 07	3.62	2.75	1.05	1.24	0.94
1985	.56	05	.36	03	2 67	3 22	3.87	2 97	1 21	1 45	1 11
1986	52	04	.41	03	2.68	3 10	3 77	3.17	1.16	1.41	1 18
1987	.48	03	.45	03	3.01	3 50	4.47	4 70	1 16	1 49	1.56
1988	43	.04	51	03	3.46	4 16	5 80	5.48	1.20	1.68	1 58
1989	40	04	.54	03	3 78	3.92	5.88	5 08	1.04	1.55	1.34
1990	41	.03	54	.02	3.94	4 47	6.35	4.81	1.14	1.61	1.22
1991	42	.02	.55	01	4 14	4 49	6 33	4 51	1.09	1.53	1.09
1992	42	02	56	.01	3.92	4 70	6 45	3.90	1.20	1.65	1.00
1993	41	.02	56	.01	3.67	3 86	6 27	3 84	1.05	1.71	1.05

[a]The prices are nominal and were adjusted to U.S. dollars using exchange rates.
[b]NWZLD/AUS is New Zealand's price relative to Australia's price over time
[c]US/AUS is the U S 's price relative to Australia's price over time.
[d]ROW/AUS is the Rest of the world's price relative to Australia's price over time

whether Japanese import policies have had differential effects on the three major beef exporters (and the rest of the world (ROW)) to the Japanese market. In particular, the paper measures expenditure and price elasticities of Japanese beef import demand from each of Japan's major beef import suppliers. In the section that follows, two import allocation models are developed and fit to Japanese beef import data by source, and the models are tested to determine which better fits the data. Expenditure and price elasticities are calculated, and, based on the analysis, implications and conclusions are drawn.

Model and Data

This study utilizes a system-wide approach (as opposed to a single equation approach) and relies on multistage budgeting under the assumption of block independence (Theil, 1976). The allocation problem facing the consumer, in this case Japan, is to allocate income among broad groups of goods (e.g., food, clothing, transportation, and education) which are assumed to be separable. Group expenditure is further allocated among the goods within the group. At this level, goods are no longer assumed to be separable.

In the first stage, following Wahl et al., the meats group is assumed separable from other groups of goods. In the second stage, expenditure for meats is allocated among the types of meats which include import quality beef as well as Wagyu beef. Finally, expenditure for beef imports is allocated among import sources. In this study, we estimate the import demand for beef by source (Australia, New Zealand, U.S., and ROW) and thus extend the research by Wahl et al.

Using the differential approach to consumer demand, one can derive the conditional demand equation for imported beef by source under block independence. Let $w_i^* = w_i/W_g$ and $\theta_i^* = \theta_i/\Theta_g$, where w_i^* is the (conditional) trade share of imported beef from country I, w_i is the budget share of imported beef from country I, S_g represents the imported beef group, $W_g = \Sigma_{i \in S_g} w_i$ is the budget share of the group S_g, θ_i is the marginal share of imported beef from I, and Θ_g is the marginal share of the group S_g (imported beef). The conditional demand equation for imported beef by source is

$$w_i^* \, d(\log q_i) = \theta_i^* \, d(\log Q_g) + \Sigma_{j \in S_g} \pi_{ij}^* \, d(\log p_j) \quad (1)$$

where p_j is the price of imported beef from source j, q_i is the quantity of imported beef from I, π^*_{ij}s are (conditional) Slutsky price parameters, and $d(\log Q_g) = \Sigma_{i \in Sg} w^*_i \, d(\log q_i)$ is the Divisia quantity index for S_g (Theil). The d in equation (1) represents a derivative for discrete changes from one year to the next. By assuming that θ^*_i and the π^*_{ij}s in equation (1) are constant, we obtain the conditional absolute version of the Rotterdam model (Theil, 1986).

If we assume the marginal shares of imported beef from $I = 1,...,n$ follow those proposed by Working, then $\theta^*_i = w^*_i + \beta_i$, and we obtain the Central Bureau of Statistics (CBS) model (Keller and Van Driel) or Working's model (Theil and Clements).[2] Accordingly, the marginal shares of the CBS model, unlike those of the Rotterdam model, are functions of income (and price) levels and thus vary over time. Substitution for θ^*_i in (1) and subtracting $w^*_i \, d(\log Q_g)$ from both sides gives the CBS model,

$$w^*_i \, (d(\log q_i) - d(\log Q_g)) = \beta_i \, d(\log Q_g) + \Sigma_{j \in Sg} \pi^*_{ij} \, d(\log p_j). \tag{2}$$

The Rotterdam and CBS models, although related, are not nested. However, following Barten one can developed a general model,

$$w^*_i \, d(\log q_i) = \beta_i \, d(\log Q_g) + \delta \, w^*_i \, (d(\log Q_g)) + \Sigma_{j \in Sg} \pi^*_{ij} \, d(\log p_j), \tag{3}$$

in which both the Rotterdam and CBS models are nested. When $\delta = 0$, equation (3) collapses to the Rotterdam model, and when $\delta = 1$, we have the CBS model. Hence, the general model can be used to test for choice of functional form between the Rotterdam and CBS models.

Operationalizing these three models utilizes additive disturbances and requires that $w^*_{it} = (w^*_{it} + w^*_{i,t-1})/2$, $d(\log x_{it}) = \log x_{it} - \log x_{i,t-1}$, where x_i represents q_i or p_i, and $D(\log Q_{gt}) = \Sigma_{j \in Sg} w^*_{jt} \, d(\log q_{it})$. All three models were fit to Japanese beef import expenditure, quantity, and price data from the United Nations, Statistical Papers. This data set was collected from 1970 - 1993 on an annual basis.[3] The data were divided into four groups: Australia, New Zealand, United States, and all other exporters (ROW).

The CBS and Rotterdam models were estimated without imposing any restrictions and with homogeneity restrictions imposed. Laitinen's exact homogeneity test did not reject homogeneity at the .10 significance level for the CBS model; for the Rotterdam model, it did not reject homogeneity at the .05 level. Symmetry restrictions were tested using likelihood ratio tests comparing the symmetry and homogeneity restricted models to those of the homogeneity restricted ones (Bewley). Symmetry could not be rejected for either the CBS nor the Rotterdam models at $\alpha = .05$.

To determine which functional form to use, the CBS, Rotterdam, and general models were estimated with homogeneity and symmetry imposed. Because the CBS and Rotterdam models are nested within the general model, a likelihood ratio test was used to test for functional form. The test is minus twice the log difference between the respective concentrated likelihood functions and is asymptotically distributed as a chi-square with q degrees of freedom, q representing the number of restrictions. The likelihood ratio test rejects the Rotterdam model at a critical value of .05; we fail to reject the CBS model at the same critical value. Accordingly, this test indicates that the CBS model fits this data set better than the Rotterdam model, and reported results are from the CBS model.

Expenditure Parameters, Marginal Shares, and Elasticities

Report parameter and elasticity estimates are all based on fitting the data with the CBS model. The estimated expenditure parameters, β_is, and their asymptotic standard errors are reported in column 6 of table 2. The (conditional) expenditure elasticity of demand for imported beef from source I of the CBS model is $\eta^*_i = 1 + (\beta_i / w^*_i)$. Thus, a zero expenditure parameter indicates unitary expenditure elasticity; a positive and significant expenditure parameter indicates an elastic expenditure elasticity while a negative and significant expenditure parameter indicates an inelastic expenditure elasticity. None of the β_is are significantly different from zero and only for the U.S. is positive.

Table 2. CBS Model Parameter Estimates of Import Allocation for Japanese Beef Imports by Source, Homogeneity and Symmetry Imposed, 1970-1993.

	Conditional Slutsky Coefficients, π^*_{ij}				Expenditure Coefficients
Exporting Country (1)	Australia (2)	New Zealand (3)	U.S. (4)	ROW[a] (5)	β_i (6)
Australia	-0.135	0.067	0.070	-0.002	-0.002
	(0.051)[b]	(0.031)	(0.039)	(0.013)	(0.029)
New Zealand		-0.111	0.047	-0.003	-0.012
		(0.029)	(0.019)	(0.012)	(0.013)
U.S.			-0.126	0.009	0.022
			(0.042)	(0.010)	(0.030)
ROW				-0.003	-0.008
				(0.010)	(0.060)

[a]ROW = Rest of the World.
[b]Asymptotic standard errors reported in parentheses.

Given that all expenditure parameters were close to zero, we tested the CBS model for homotheticity or unitary elasticities. The models are nested so the likelihood ratio test was again implemented. The test fails to reject homotheticity at the critical value of .05. The log likelihood value with homogeneity and symmetry imposed was 188.77; with homotheticity, it was 187.79.

The implication of homothetic expenditure elasticities of Japanese demand for all beef imports by source is that Japan did not discriminate in the beef import market; without changes in relative prices, the trade shares would have remained unchanged.[4] Thus, we look for evidence based on relative price changes to explain the observed changes in the trade shares.

Prices, Price Parameters, and Elasticity Estimates

Given homotheticity, the question remains, "why did Australia's trade shares decrease and the U.S.'s increase?" The answer seems to lie in the relative price changes. Inspection of the changes in Japan's beef prices over time for imported beef (table 1, columns 6-9) shows that Australia's and New Zealand's prices have increased approximately four fold from 1970 to 1993. During the same time period, U.S. beef prices to Japan increased a little more than 1.5 fold.[5] Columns 10-12 of table 1 show the changes in relative prices with respect to Australia. Australia's prices have been increasing at a faster rate than those of U.S. beef while they have increased at a similar rate with those of New Zealand and the ROW beef. Instead of the discrimination hypothesis, changes in relative prices over time may explain the movements in the trade shares for Australia and the U.S.

The price parameters were reestimated using the CBS model with homotheticity imposed. The conditional Slutsky price parameters for the homothetic CBS model (symmetry and homogeneity imposed) are reported in columns 2-5 of table 3. All own-price parameters are negative and significantly different from zero (α = 0.05) with the exception of ROW. This indicates that the own prices play a significant role in explaining the changes in the trade shares. Of the six cross-price parameters, two are significantly different from zero for α = 0.05 and two others for α = 0.10. These are Australia-U.S. (positive), New Zealand-U.S. (positive), Australia-New Zealand (positive), and U.S.-ROW (positive).

Conditional Slutsky price elasticities (s_{ij}) can be calculated as $s^*_{ij} = \pi^*_{ij}/w^*_i$ and are reported in

Table 3. Homothetic CBS Model's Price Parameter Estimates and Slutsky Price Elasticities of Import Demand for Japanese Beef Imports by Source Estimated at Sample Means, 1970-1993.

Exporting Country	Price Parameters				Price Elasticities			
	Australia	New Zealand	U.S.	ROW[a]	Australia	New Zealand	U.S.	ROW
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Australia	-0.124	0 058	0.076	-0.007	-0.20	0.09	0 12	-0.01
	(0.045)[b]	(0.030)	(0.033)	(0.014)	(0.07)	(0.05)	(0 05)	(0.02)
New Zealand		-0.110	0.055	-0 003	1.10	-2.09	1 05	-0.06
		(0.029)	(0.017)	(0.012)	(0.56)	(0.55)	(0 33)	(0.23)
U.S.			-0.147	0.015	0.25	0.18	-0.48	0.05
			(0 035)	(0.009)	(0.11)	(0 06)	(0 12)	(0.03)
ROW				-0.005	-0 41	-0 19	0.91	-0 30
				(0.010)	(0.81)	(0.71)	(0.52)	(0.56)

[a]ROW = Rest of the World
[b]Asymptotic standard errors in parentheses

table 3, columns 6-9, calculated at sample means. Slutsky elasticities hold real income and all other prices constant as the price of good *I* is changed; it reflects pure substitution effects. All own-price Slutsky elasticities are negative; those of Australia, New Zealand, and the U.S. are significantly different from zero ($\alpha = 0.05$). Australia's and the U.S.'s own-price elasticities are inelastic (-0.20 and -0.48, respectively), New Zealand's is elastic (-2.09) and significantly different from unitary ($\alpha = 0.05$), and ROW is inelastic but not significantly different from zero ($\alpha = 0.05$). These results indicate that, if the price of Australian beef drops by 1 percent, the quantity demanded will increase by approximately 0.2 percent. If the price of U.S. beef drops by one percent, the quantity demanded will increase by approximately 0.5 percent; if New Zealand's beef price decreases by 1 percent, the quantity demanded will increase by 2.1 percent. The ROW beef demand will not be significantly affected by a change in own price.

Wahl et al. estimated the own-price elasticity of Japanese demand for import quality beef conditional on total meat expenditure as unitary (-0.98). Accordingly, the own-price elasticities of demand for beef imports by source, conditional on total meat expenditure, will equal (approximately and statistically) those conditional on Japanese beef imports expenditure. Similarly, expenditure elasticities of demand for imported beef from source *I* conditional on total meat expenditure (η_i) can also be calculated using $\eta_i = \eta_g \eta_i^*$ where η_g is the expenditure elasticities of demand for S_g (import quality beef), and η_i^* is the expenditure elasticities of demand for beef imports from source *I* conditional on total beef imports expenditure. Using $\eta_g = 1.51$ from Wahl et al. and that all of the η_i^* are equal to one, η_i is also equal to 1.51 for every beef exporter to the Japanese market; all expenditure elasticities for imported beef by source conditional on total meat expenditures are elastic. Accordingly, as Japanese expenditures on total meats increase by 1 percent, expenditures on beef imports will increase by more than 1 percent (1.5 percent).

Own-price elasticities can be calculated over time; these estimates are reported in table 4, columns 1-4. Australia's own-price elasticities have increased over time implying that demand for Australian beef has become more own-price elastic. The U.S. own-price elasticity fluctuated throughout the 1970s, but since 1980, its own-price elasticity has steadily decreased (i.e., becoming more inelastic). Indeed, by 1993 the own-price elasticity for Australian beef (-0.31) was more elastic than that of U.S. beef (-0.26). The other two elasticities have fluctuated over time with New Zealand's being elastic and becoming more elastic and with the ROW's being inelastic and becoming more inelastic over time until 1992.

A Slutsky cross-price elasticity (table 3, columns 6-9) indicates complementary goods if its sign is negative and substitute goods if its sign is

Table 4. Slutsky Own-Price Elasticities over Time.

Year (1)	Australia (2)	New Zealand (3)	U.S. (4)	ROW (5)
1970	-0 16	-0.79	-3.44	-0.20
1971	-0 15	-1 09	-3.30	-0.56
1972	-0 14	-1.46	-5.40	-0.95
1973	-0.15	-1.72	-2.11	-0.72
1974	-0.16	-1.85	-0.97	-0.68
1975	-0.18	-1.62	-0.73	-0.37
1976	-0.18	-1.63	-0 66	-0.42
1977	-0 17	-1 89	-0.75	-0.40
1978	-0.18	-1.60	-0 79	-0.25
1979	-0.18	-2 15	-0.65	-0.26
1980	-0.18	-3.26	-0.61	-0.27
1981	-0.19	-2.31	-0.57	-0.25
1982	-0.20	-2.45	-0 47	-0.35
1983	-0.21	-2.42	-0 44	-0.81
1984	-0.21	-2.02	-0.44	-0.36
1985	-0.23	-2.21	-0 40	-0.21
1986	-0.24	-2.67	-0.36	-0.20
1987	-0.26	-3.22	-0 32	-0.17
1988	-0.30	-3 11	-0.29	-0.16
1989	-0 32	-3.15	-0.27	-0.18
1990	-0.31	-3.78	-0.27	-0.24
1991	-0 30	-4 83	-0.27	-0.36
1992	-0.31	-5.56	-0.26	-0.63
1993	-0 31	-5.27	-0 26	-1.03

positive. Of the 12 cross-price elasticities, six were statistically different from zero ($\alpha = 0.05$): those of Australia-New Zealand, Australia-U.S.,New Zealand-Australia, New Zealand-U.S, U.S.-Australia, and U.S.-New Zealand; those of U.S.-ROW and ROW-U.S. were significantly different from zero at the $\alpha = 0.10$ level. Of these, all were positive, implying that Australian, New Zealand, and U.S. beef are all substitutes.

Conclusion

The CBS, Rotterdam, and general models were fit to data for beef exporters to the Japanese market. Results from the likelihood ratio tests indicated that the functional form of the CBS model fit this data set better than that of the Rotterdam model. The expenditure elasticities from the CBS model were all unitary; accordingly, homotheticity was tested and could not be rejected. This result indicates that, in the absence of relative price changes, the trade shares of beef exported to Japan would not have changed. From this, one can conclude that the Japanese did not discriminated against Australian beef imports. The analysis does, however, suggest that the changes in trade shares over time are due to relative price changes between Australia and U.S. beef prices. Australia, New Zealand, and the U.S. all had negative and significant own-price elasticities, and Australia's own-price elasticities have become more elastic and the U.S.'s less elastic over time. Over the period of study, the U.S. price relative to that of Australia has decreased from 4.2 to 1.7. Finally, all of the exporters of beef to Japan stand to gain as expenditures for total meats increase.

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Endnotes

1. Additionally, the Australians have complained that Japan favors U.S. imports in other goods, particularly automobile parts, and have filed a complaint under GATT (*The Wall Street Journal*).

2. β_i represents the difference between the marginal share and the average share. If $\beta_i > 0$ then the marginal share exceeds the average share by β_i and is elastic. $\beta_i = 0$ indicates unitary elasticity. W_i is not constant with respect to income and price, hence the marginal share is not constant (Theil and Clements, 1987).

3. The prices are nominal and were adjusted to U.S. dollars using exchange rates.

4. There have been several papers written in recent years that have criticized the Armington model for its assumptions (Alston et al., 1990; Davis, 1993). Our findings suggest that for this data set the Armington model, should provide an accurate estimate.

5. ROW's prices have increased 2.6 fold from 1970 - 1993.