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JAPANESE SEAFOOD DEMAND

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The Japanese food market is undergoing substantial change. Increased 'westernisation' of the Japanese culture is likely to have had some influence on the pattern of food demand. In addition, the easing of import restrictions in the beef industry is forecast to increase beef consumption by 15 per cent within two years, and the boom in world aquaculture production has led to a fall in prawn prices and a 90 per cent rise in stock levels in just 4 years.

This study analyses the implications of these changes on future seafood demand. Price relationships between seafood and meat products, and between the three seafood products, are estimated using parameters obtained from the modelling. A number of other issues are also addressed, such as the growth in away-from-home consumption and differences in consumption behaviour according to age groups.

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Introduction

Although Australia supplies only about 3 per cent of Japanese fishery imports, Japan is the largest export market for Australian seafood. Sales to Japan in 1988-89 were valued at $339m, 60 per cent of Australia's total fishery exports. The major products traded were prawns ($152m), rock lobster ($82m), and abalone ($80m).

The objective of this paper is to analyse demand relationships for seafood and meat products in Japan at three levels: aggregate demand, household demand and demand outside the home. Three seafood commodities - crustaceans, tuna and other fish - and three meat commodities - beef, pork and chicken - are considered.

The Changing Face of the Japanese Market

Japan has one of the highest consumption rates of fishery products, both in aggregate and per person, of any country in the world (FAO 1987). The Japanese people have traditionally included considerable quantities of fishery products in their diet, partly as a consequence of the highly productive seas that surround the island nation and the limited availability of arable land.

Since the 1960s, fundamental changes have been occurring in the dietary patterns of the Japanese people. The amount of food consumed has not altered greatly, since average calorie intake per person has grown only moderately (from 2200 calories per day in 1960 to around 2500 calories per day in 1980 (Kester 1980)), but the composition of their food intake has changed considerably. Meat and seafood consumption has doubled, from 32.8 kg (product weight) in 1960 to 61 kg in 1985, while consumption of carbohydrates, predominately rice, has steadily fallen - from 115kg per person in 1960 to 88kg in 1975 and 73kg in 1986 (ABARE 1988).

Fisheries consumption has been increasing at a slower rate - though from a higher base - than meat products, with the result that fisheries share of meat and seafood consumption (as measured by average daily intake of animal protein) has fallen from 74 per cent to 44 per cent over the 25 year period.

TABLE 1: Average daily intake of animal protein per person in Japan

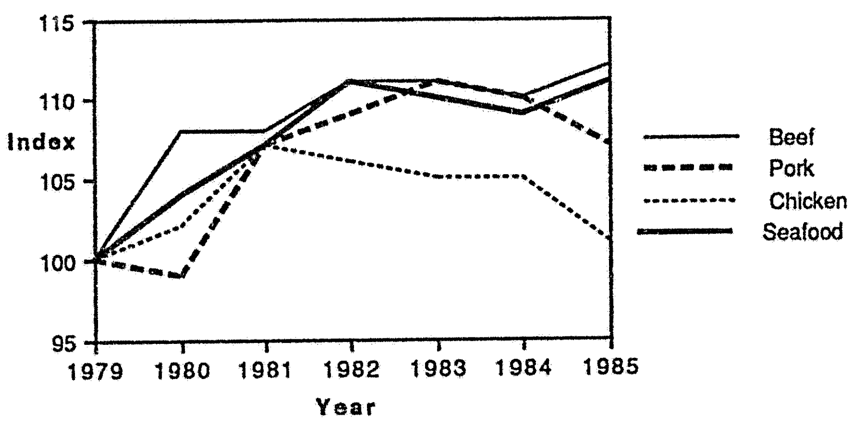
Year	Fresh fish and shellfish	Livestock Products: Meat	Hen Eggs	Dairy	Total	Total
	g	g	g	g	g	g
1960	15.6	1.7	2.2	1.7	5.6	21.2
1965	16.4	3.5	4.0	3.0	10.5	26.9
1970	16.6	6.0	5.2	4.0	15.2	31.8
1975	18.1	8.5	4.9	4.2	17.6	35.7
1980	17.9	11.4	5.1	4.9	21.3	39.1
1985	18.3	12.6	5.0	5.3	22.9	41.2

Source: ABARE (1988)

Changes have also occurred in the mix of products consumed within the seafood and the meat categories. In the seafood market, lower valued species have been replaced by more preferred, higher valued species, and the consumption of pork and poultry has risen much faster than that of beef.

A number of factors are responsible for these dietary changes. Fisheries products have become more expensive relative to pork and chicken, as shown in Figure 1. The change in market shares may partly reflect consumer reaction to these price movements.

FIGURE 1: Relative price movements over time



The increase in meat and seafood consumption may be due to the rising income levels of Japanese consumers. Real wages increased by about 8 per cent a year in the late 1960s and early 1970s. Although the rate has since slowed, growth remains strong, with real wages increasing by around 4.5 per cent in 1985, 3 per cent in 1986 and 3.5 per cent in 1987 (ABARE 1988).

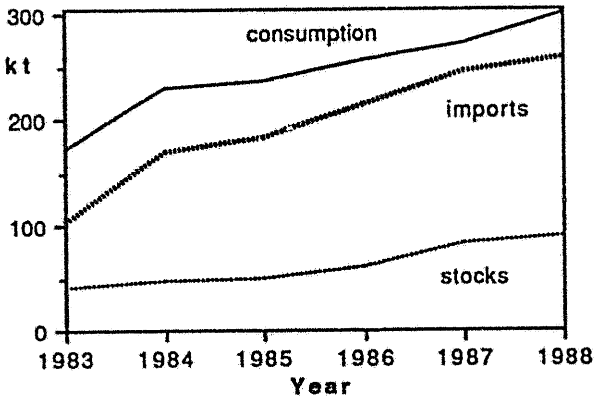
These changes in consumption may not be entirely due to price and income effects. Changes in lifestyle associated with increasing 'westernisation' of Japanese culture are also likely to have influenced food demand. Hirasawa (1983) has argued that one of the reasons for the increase in meat consumption was the decline in the number of households with extended families, while Ohtagaki (1986) suggested that the convenience of preparing meat has encouraged the trend away from time consuming traditional fish and rice meals.

Government action during the late 1950s and the 1960s was directed at improving the level of animal protein in the Japanese diet. Pork and poultry supplies expanded rapidly, but beef supplies were difficult to increase on account of the limited availability of land and government support for protection of the domestic industry. The Japanese beef market has been highly regulated: the imposition of a quota on beef imports has restricted supplies, and a complex set of price stabilisation schemes maintained domestic prices at artificially high levels. The recent decision to liberalise the industry is likely to have an impact on the demand for a range of meat and competing seafood products. This development should be of particular interest to Australian seafood exporters, since beef is thought to compete directly with high valued Australian seafood at the premium end of the Japanese market.

There have also been major changes over the past 10 years in Japanese supplies of seafoods. The introduction of exclusive economic zones in the mid 1970s reduced Japanese access to foreign fishing waters. Japanese catches from offshore fisheries have continued to increase, however, due to a major increase in landings of lower valued species, such as sardines, which do not meet the growing consumer demand for premium seafood. The composition of the catch has not kept pace with changes in demand, and Japan - a net exporter of fisheries products in the 1970s - is now the world's largest seafood importer, buying over 25 per cent of the value of fisheries products traded in 1988. The increase in imports has been concentrated on high quality species such as tuna, shellfish, groundfish and roe.

The growth in world prawn aquaculture production during the mid-1980s has been spectacular, increasing from 84 kt in 1982 to a forecast 500 kt in 1990. Japan has been the destination for much of this cultured prawn product, with prawn imports doubling between 1983 and 1988. Given that Japanese prawn catches were reasonably stable during this time, the growth in imports represents a significant increase in prawn supplies to the Japanese market. Prawn prices have fallen, and cold storage holdings have risen 90 per cent since 1984 (see figure 2).

FIGURE 2: Prawn consumption, imports and stocks 1983 - 1988



The long term effects of the build-up in prawn supplies - and subsequent fall in price and increase in consumption - on the demand for other seafood and meat products have not previously been examined.

Previous Studies

A number of studies have sought to estimate price and income elasticities for seafood in Japan, and Coyne (1983) has summarised the results from a number of these. Many are now dated (eg FAO 1971; MAF 1971 and 1974) and, given the changes that have occurred in demand, the results from early studies are unlikely to be relevant to current consumption behaviour.

Kester (1980) used annual per capita consumption data for a range of intervals over the years 1960-1978 to estimate price and income elasticities for fish and meat products. A range of linear, semi-log and double-log functional forms were used in the analysis. Her results suggested that the income elasticity of fish was low relative to other meats and was falling over time. Kester also found that the own price elasticity of demand for fish was low relative to other meats, and that the pattern of fish consumption could not be fully explained by price and income factors.

Teal, Dickson, Porter and Whiteford (1987) analysed annual Japanese meat and fish expenditure data for the period 1966-1985. Unlike the single equation methods employed by Kester, Teal et al used a systems approach - the Almost Ideal Demand System (AIDS) - to estimate a meat and fish expenditure system containing four commodities - beef, pork, chicken and fish. Teal et al found that fish demand was price inelastic and that fisheries' share of meat and fish expenditure would decline with rising income levels. The results from their study are presented in Tables 2a and 2b.

TABLE 2a: Estimated price elasticities

Elasticity of demand for	with respect to price of			
	Beef	Pork	Chicken	Fish
Beef	-0.87	0.15	-0.13	0.59
Pork	0.03	-0.27	-0.02	-0.03
Chicken	-0.15	0.07	-0.52	0.34
Fish	0.19	0.08	0.08	-0.55

TABLE 2b: Estimated income elasticities

Elasticity of demand for	with respect to	
	a	b
Beef	1.12	1.31
Pork	1.21	1.41
Chicken	1.15	1.34
Fish	0.81	0.95

with income represented by a) total expenditure on meat and fish, and
b) total household final expenditure

Source: Teal et al (1987)

The fish elasticity estimates from both analyses need to be interpreted with caution because of the problems associated with aggregating numerous seafood types into one category. Given that the Japanese consume more than 500 different marine products, Kester comments that aggregation and averaging 'inevitably reduces the rigor of the analysis' (Kester 1980). Teal et al's principal aim was to analyse the demand for beef, so the aggregation of fish commodities was not an important issue in that study.

Both studies concluded that an increase in income - Teal et al used expenditure as a proxy for income - will lead to a less than proportional increase in fish consumption. Since only one fish category was used in these two studies, high valued and low valued species were grouped together, with the result that they were unable to identify any changes which might have been occurring in the composition of seafood consumption.

In an attempt to address the heterogeneity of demand for fish species, Kitson and Maynard (1983) studied the demand for high valued fish in Tokyo. They examined the distribution channels and end uses for high valued fish species, defining 'high valued' as species valued at more than ¥1000/kg at the Tokyo wholesale markets in 1980. They also reported the results from earlier Ministry of Agriculture, Forestry and Fisheries (MAFF) work that estimated price and expenditure elasticities for a range of seafood products. These estimates are given in Table 3.

TABLE 3: Elasticity estimates from MAFF

Elasticity of demand for	with respect to Own price	Income
High priced	1.39	1.77
Medium priced	0.70	0.14
Low priced	0.37	0.20

Source: Kitson and Maynard (1983)

The MAFF study concluded that the demand for high valued fish was responsive to changes in both own price and income but that demand relationships for medium and lower priced species were difficult to establish.

The aggregation problem has direct relevance to this study given that Australia specializes in the high quality section of the market, and it is desirable to disaggregate demand into high and low valued species. The data and the estimation methods used to approach the problem are discussed in the following two sections.

Data

Information was collected at the household and aggregate levels. Data for away from home consumption were derived as the residual of aggregate minus household consumption. Because most of our seafood exports are consumed at functions and ceremonies rather than as household meals, the away from home sector has particular relevance to Australia exporters .

Data for the household study were derived from annual surveys of household consumption and expenditure conducted by the Japanese Statistics Bureau. Household expenditure surveys have been conducted annually since 1963, but crustaceans have been a separate category only since 1979. The household analysis was therefore limited to the period 1979 to 1986.

The survey reports household averages for a number of different social indicators, such as geographic, income and age groups, but the indicators are not cross referenced. The data selected for this analysis were household averages stratified by average age of the household head.

The data collected were average household consumption of fresh meat and seafood. Consumption was broken down into six categories: beef, chicken, pork, tuna, crustaceans and other fresh fish. The variables included were consumption, price, household expenditure, age of household head and number of people per household.

For the aggregate model, annual consumption estimates for beef, pork, and chicken were obtained from MAFF(1987). These data were converted to a net food basis and divided by the total population to determine annual per person consumption. The corresponding series for fresh fish and shellfish consumption could not be disaggregated into separate product categories, so that an 'apparent consumption' series was derived, defined as:

(1) apparent consumption = (imports + domestic production) - (exports + changes in stock levels).

Apparent consumption series were calculated for crustaceans and tuna. Import and export information was collected from trade data compiled by the Japanese Finance Ministry. Domestic production data were obtained from MAFF (1987). Data for prawn stocks were drawn from Suisan Nenkan (1985). It was assumed that the stocks of other crustaceans had not changed significantly over the period. Details of tuna stocks were obtained from data supplied by the Japanese External Trade Organisation (JETRO). Annual other fresh fish consumption was obtained by subtracting the series for crustaceans and tuna from the aggregate fish consumption series. Annual wholesale prices were obtained for beef, pork and chicken from MAFF (1987). Corresponding series for fish, tuna and crustaceans were calculated using data from this same source.

Income is represented by expenditure in the AIDS model, and per person expenditure was calculated by dividing average family living expenditure by the average number of people per family. Data for these calculations were obtained from the annual household expenditure surveys.

Model

Demand was estimated using the Almost Ideal Demand System developed by Deaton and Muellbauer (1980). Parameter estimates for the demand equations are derived by estimating a system of value share equations. Using this systems approach, the restrictions of homogeneity, compensated price symmetry and adding up can be imposed directly through the model, thereby improving the efficiency of the parameter estimates.

The general form of the share equations is given by:

(2) $$w_i = a_i + \Sigma b_{ij} \ln (p_j) + \ddot{y}_i \ln(E/P^*)$$

where w_i represents the share of expenditure on commodity i, a_i, b_{ij} and $\ddot{y}_i$ are parameters to be estimated, p_j is the price of product j, E is expenditure and P* represents Stone's price index, calculated as:

(3) $$P^* = \Pi \, p_j^{\,w_j}$$

The restrictions on the model parameters are given by:

$\Sigma b_{ij} = 0,$ homogeneity ,
$b_{ij} = b_{ji},$ symmetry,
$\Sigma a_i = 1,$ and
$\Sigma \ddot{y}_i = \Sigma b_{ij} = 0,$ adding up.

The model was applied to a two-stage demand system. In the first stage, expenditure was allocated between three meat products - beef, pork and chicken - and seafood. In the second stage, the seafood group was disaggregated into three commodities - crustaceans, tuna and other fish. Imposing the structure of a two step budget allocation reduced the number of parameters to be estimated from 15 to 9. This improved the potential efficiency of parameter estimation, though at the expense of limiting the flexibility of the relationships between the individual seafood and meat categories. Results from the four AIDS models are presented in appendix A.

The richness of the data available for the household level analysis enabled demographic variables to be incorporated into the share equations in addition to the price and expenditure variables. Age of the household head was included to account for differences in consumption between the age cohorts, and a time/age variable was included to allow for changes in the pattern of consumption within cohorts over the sample period. A simple time variable was also included.

Comparable demographic data were not available for the aggregate level study, and the only addition to the general form of the AIDS equation for the aggregate analysis was the inclusion of a time variable.

The parameters from the AIDS equations were used to derive own-price and cross-price elasticity estimates for each food category. Implicit in these elasticity estimates is the assumption that the level of expenditure in the specified system is held constant, an assumption which is too restrictive for this study. Seafood constitutes about 60 per cent of household meat and seafood consumption, and it is likely that a change in the price of seafood would cause the level of expenditure on meat and seafood to change. The expenditure constraint needs to be removed in order to obtain more realistic elasticity estimates. This was achieved by estimating the relative responsiveness of meat and seafood expenditure to changes in the price of meat and seafood commodities. The following model was estimated using a single equation regression:

(4) $$\ln E = a + b_1 \ln P_{oth} + b_2 \ln P^* + b_3 \ln Y + b_4 T$$

where

E = aggregate meat and seafood expenditure
Poth = an index to represent the price of foods other than meat and seafood

P* = an index ($\Pi\, p_j^{w_j}$) to represent the price of meat and seafood
Y = income (as measured by average household living expenditure), and
T = a time variable.

The expenditure equation at the household level included a set of dummy variables to allow for changes in expenditure patterns for different age groups. The results of the two expenditure regressions are presented in appendix B.

Since the model is in double log form, the parameter estimates represent expenditure elasticities, and given a change in price of commodity q_i the proportional change in expenditure is given by (bi*wi). Since the effects of a change in price on the level of expenditure are known, the uncompensated price elasticities can be determined. The derivation of the at home and away from home elasticity formulas is outlined in appendix C, and the formulas for the elasticities for the away from home sector are derived in appendix D.

The three stages of estimation outlined above - the single equation expenditure regression, the AIDS model with four food commodities, and the AIDS model with three seafood commodities - were completed at both the household and the aggregate level. The estimation procedure is illustrated in the following diagram:

Figure 3: Estimation procedure

	System	Household	Away from home
First stage		Estimation of expenditure regressions	
Second stage	Meat and seafood system with four commodities	AIDS + time + demographics	AIDS + time
Third stage	Seafood system with three commodities	AIDS + time + demographics	AIDS + time

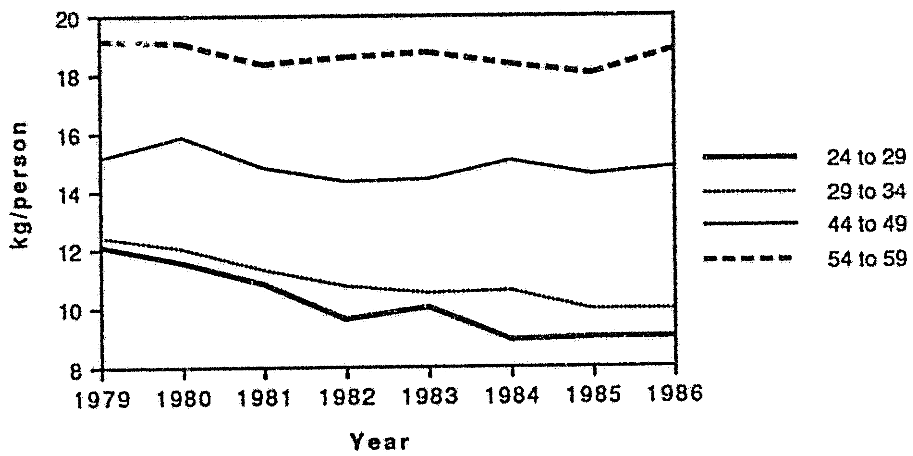
Discussion of Results

Influence of demographic variables

As previously noted, the Japanese diet has become more 'westernized' in recent years. One aspect of this study was to consider whether these changes have occurred evenly across the Japanese population or whether the rate of change varies according to differences in age group. This is an important consideration, for if the changes are concentrated in the younger age groups, seafood demand will continue to fall as the population ages.

Annual data on household food consumption, stratified by age of household head, were analysed from 1979 to 1986. As shown in Figure 4, seafood consumption for the older age groups has fluctuated about their 1979 levels and no downward trend was apparent. In contrast, consumption by young people declined substantially during the same period. This result suggests that the consumption patterns of the young people are changing more than that of the older age groups. Some middle-age groups registered slight falls in seafood consumption but none was as pronounced as the decline among younger age groups.

FIGURE 4: Household seafood consumption by age groupings



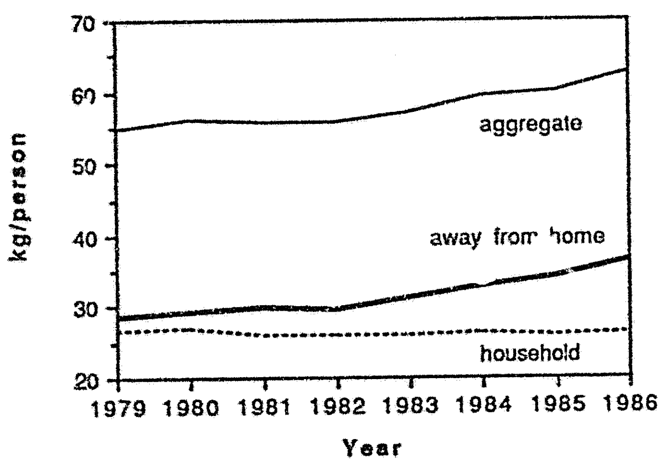
The graph relates to household seafood consumption, not total consumption. Young people are definitely eating less fish at home in 1986 than they were in 1979, but their consumption of seafood from other sources such as sushi bars and restaurants may have increased. Household consumption is only part of the picture, and information is needed on the developments in the away from home sector in order to fully understand the changes in consumption.

Insufficiently detailed data were available on away from home consumption and total consumption by age group, but the pattern of away from home food expenditure by young people remains an important area for further work.

Growth in away from home consumption

An important effect of Japan's increasing prosperity is that the quantity of meat and seafood eaten outside the home has steadily increased, as shown in Figure 5.

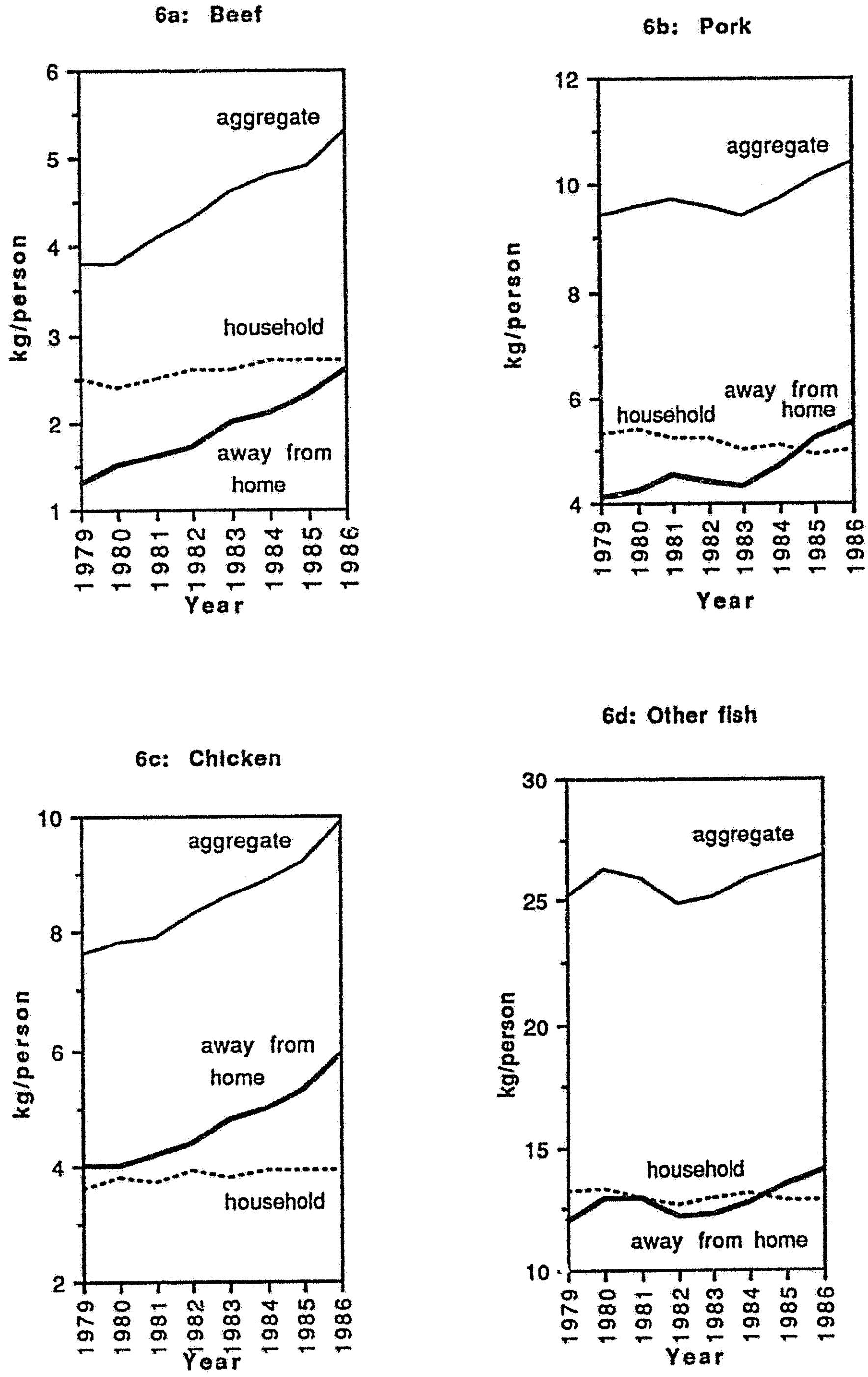
FIGURE 5: Growth in meat and seafood consumption



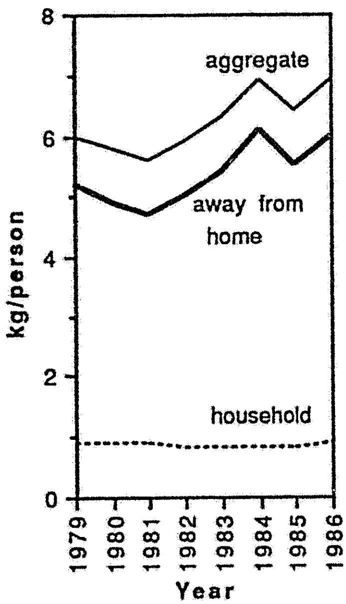
Given Australia's role as a supplier of high valued seafood to the Japanese market, it is important to identify those products that are most affected by the increase in away from home consumption.

Figure 6 gives the levels of home and away from home consumption for each of the commodities analysed in this study.

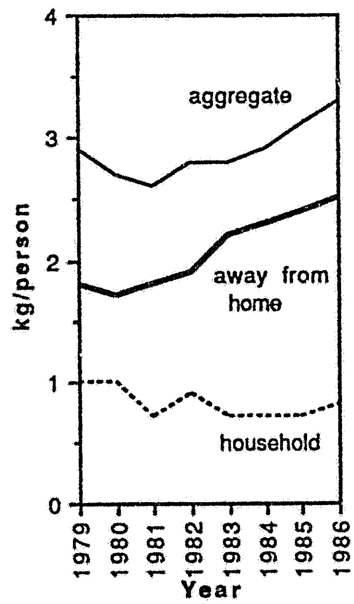
FIGURE 6: Consumption of the six major commodity types



6e: Tuna



6f: Crustaceans



These graphs suggest that Japanese consumption patterns are changing significantly. The trends in the six graphs are remarkably consistent: household consumption is stagnant, in some cases falling, and consumption away from home is increasing. There has been strong growth in the non-home market for each seafood and meat product considered in this study.

Estimated price relationships

Own price and cross-price elasticities were calculated using the parameter estimates from the model and mean value shares for the sample period. The following tables contain the elasticity estimates from the two demand systems at the aggregate, household and away from home sectors of the market. The t ratios given below the estimates were calculated using Monte Carlo simulations of the parameter estimates using the variance-covariance matrix of the estimates.

Table 4a: Aggregate meat and seafood system

Elasticity of demand for	with respect to price of			
	Beef	Pork	Chicken	Seafood
Beef	-0.62	0.24	-0.10	0.36
	(3.6)	(2.0)	(1.0)	(1.9)
Pork	0.18	-0.52	-0.10	0.15
	(1.8)	(4.3)	(1.0)	(1.0)
Chicken	-0.09	-0.06	-0.57	0.61
	(1.0)	(0.5)	(3.2)	(2.5)
Seafood	0.12	0.07	0.26	-0.77
	(1.7)	(1.0)	(3.2)	(4.5)

Table 4b: Aggregate seafood system

Elasticity of demand for	with respect to price of		
	Crustaceans	Tuna	Fish
Crustaceans	-0.39	-0.20	-0.54
	(2.8)	(2.0)	(3.0)
Tuna	0.01	-0.45	0.02
	(0)	(5.6)	(0)
Fish	-0.14	-0.10	-0.58
	(3.5)	(2.5)	(6.4)

Table 5a: Household meat and seafood system

Elasticity of demand for	with respect to price of			
	Beef	Pork	Chicken	Seafood
Beef	-1.1	0.14	0.04	0.42
	(7.2)	(1.4)	(0.5)	(2.3)
Pork	0.16	-0.4	-0.01	-0.2
	(1.6)	(2.7)	(0.1)	(1.0)
Chicken	0.11	-0.01	-0.39	-0.13
	(0.5)	(0)	(1.0)	(0.5)
Seafood	0.19	-0.04	-0.01	-0.43
	(3.2)	(0.5)	(0)	(2.4)

Table 5b: Household seafood system

Elasticity of demand for	with respect to price of		
	Crustaceans	Tuna	Fish
Crustaceans	-3.17	0.62	2.17
	(9.6)	(2.4)	(8.0)
Tuna	0.54	-1.15	0.07
	(2.3)	(3.5)	(0)
Fish	0.24	0.02	-0.68
	(8)	(0)	(14)

Table 6a: Away from home meat and seafood system

Elasticity of demand for	with respect to price of Beef	Pork	Chicken	Seafood
Beef	-0.12	0.34	0	0.30
Pork	0.20	-0.63	0	0
Chicken	0	0	-0.69	1.0
Seafood	0.08	0	0.43	-0.99

Table 6b: Away from hcme seafood system

Elasticity of demand for	with respect to price of Crustaceans	Tuna	Fish
Crustaceans	0.49	-0.46	-1.4
Tuna	-0.08	-0.35	0
Fish	-0.49	0.19	-0.49

The results obtained from the aggregate model are generally comparable with those obtained by Teal et al. The compensated demand elasticities for seafood, pork, and chicken were higher, and the elasticity for beef demand was lower than that in Teal's analysis. These differences are not surprising because the income effects of a price change for seafood, chicken and pork are likely to be larger than those for beef, a hypothesis consistent with the relative importance of each item in aggregate consumption patterns. Demand for individual seafoods was found to be inelastic. A surprising aspect of the results was the complementary relationship that exists among the seafood commodities.

The household level results were consistent with expectations. The demand for beef was found to be elastic, a result consistent with its luxury status, while other meats showed a similar own-price responsiveness. The strong substitution relationship between beef and seafood and the lack of a significant own price elasticity estimate for chicken were the main results.

The analysis of demand outside the household, determined as the residual relationship between aggregate consumption and household consumption, was less satisfactory. The demand for beef was found to be less responsive to changes in own price than to changes in seafood and pork prices. Consumption in this sector would be expected to be relatively unresponsive to changes in wholesale prices because food costs are only a small proportion of the total meal costs, but it is not readily apparent why consumption should be more responsive to the wholesale prices of other meats. The elasticity estimates for crustacean demand outside the household was positive and thus not acceptable. Given its importance to the Japanese seafood market, away from home demand requires further study.

One of the problems with analysing Japanese seafood demand is the difficulty of classifying the vast range of seafood products into manageable and meaningful categories. A system of three categories was used in this study - crustaceans, tuna, and other fish, yet this division is not without its problems, since there are significant differences in quality among these categories. Premium taisho prawns and common white prawns have been treated as common items in the crustaceans group, the low valued horse mackerel and the far preferred whiting appear together in the fish category, and quality differentials in tuna are equally wide. Such aggregation problems increase the scope for error in these estimates.

<u>Relationship between seafood and beef</u>

An understanding of the relationship between seafood and beef is of particular concern to the Australian industry following the recent decision to liberalise the Japanese beef industry. Beef supplies are forecast to increase rapidly, and by 1991 consumption is expected to be 15 per cent above current levels.

Changes in the price of seafood have a far greater impact on beef demand than vice versa, an expected result in view of their relative importance in consumption. The findings from this study also suggest that there is some competition between beef and seafood products, but that most of this substitution takes place at the household level.

The magnitude of the expected change in beef consumption following trade liberalisation is sufficient to alter existing consumption behaviour, and the results may understate its effects on seafood demand. Liberalisation of the beef industry will have a substantial effect on the demand for seafood, but the change in consumption will be strongest at the household level. Since Australian seafood is targeted at the away from home market, our exports should not bear the full force of the changes in consumption.

The findings suggest that pork consumption will be most adversely affected by a fall in beef prices. This will incur some second-round effects on seafood demand should pork prices fall, but this impact should be only slight and should occur mainly at the household level.

Substitution between seafood and chicken

A surprising feature of the results was the strong substitution relationship between seafood and chicken. It appears that chicken, not beef (as commonly thought), provides the greatest competition to seafood demand. The substitution, moreover, is strongest in the away from home sector of the market.

This substitution may be explained partly by movements in the relative prices of seafood and chicken in recent years. As shown in Figure 1, chicken has become cheaper relative to seafood and other meats. The implication is that any further falls in the price of chicken will have a substantial impact on seafood demand, especially in the away from home market. This result, when combined with the the high responsiveness of chicken demand to changes in income found in other studies, suggests that increased chicken production, and a continued fall in its relative price, will have a major effect on the future demand for seafood.

Impact of aquaculture on seafood demand

At the aggregate level, the demand for seafood is relatively responsive to changes in seafood price. Consequently, any fall in seafood price as a result of the increased supplies from aquaculture will have a substantial impact on seafood demand, and this impact will be strongest in the away from home sector. The household market is not so responsive to changes in price, implying that factors other than price, such as tradition, are important influences on seafood consumption.

Examining the price effects on the demand for the individual seafood categories (Table 5), the price responsiveness of the three commodities at the aggregate level is of similar magnitude. A surprising aspect of the aggregate analysis is the complementarity between seafoods. This is also evident in the away from home sector, a result which may be partly explained by the combining of many different seafood products in meals eaten out. The relationship between seafood products is an area that requires further research.

The aggregate and away from home results contrast with the results obtained from the household analysis, where individual categories exhibit strong price responsiveness and there is substitution among the seafood products. This contrast is consistent with the message from the earlier consumption graphs - that the household and away from home sectors of the market behave very differently. The graphs indicate that the consumption trends in the two sectors have been different, and the estimates suggest that the consumer response to price movements in the two sectors is also different.

Any fall in crustacean prices should increase overall crustacean consumption, with the greatest growth occurring at the household level. Trade information supports this view, for although the household market represented only 25 per cent of total crustacean consumption in 1986, around half of the increased prawn supplies in 1988 were reportedly being sold through supermarkets for household consumption. There appears to be considerable potential to increase household crustacean consumption, though the substitution relationships at the household level suggest that some of this increase will be at the expense of reduced tuna and fish consumption.

In contrast, in the away from home sector the fall in crustacean price will lead to a significant rise in consumption of fish and a smaller increase in that of tuna.

The nett effect of a decline in prawn prices will be to boost demand for prawns, particularly at the household level. Fish consumption should increase, though tuna consumption will be little effected.

The implications for Australian prawn exporters are not bright: given their role as a supplier of high valued prawns, they are not well placed to compete with the aquaculture product at the retail level.

Conclusions

The food consumption patterns of Japanese people are changing. The quantity of seafood consumed at home is decreasing, particularly among young people. More work is needed to determine whether they are eating less seafood in total or are merely replacing seafood eaten at home with that eaten out.

The at home sector is not as responsive to changes in price as the away from home sector, implying that factors other than price (e.g. tradition) are important influences on consumption.

There has been strong growth in the away from home market for all products considered in this study. This market is price competitive, and any reduction in price is likely to stimulate demand for that product.

Any fall in beef price due to increased supplies is likely to boost beef consumption, especially at the household level. The size of the increase in beef consumption - forecast to rise by 15 per cent by 1991 - is great enough to affect seafood demand substantially. Most of the decline in seafood consumption will occur at the household level, however, and its effects on the demand for premium Australian exports should not be severe.

There is strong substitution between chicken and seafood products, particularly in the away from home sector, a conclusion which suggests the need for further research into the chicken-seafood relationship.

Continued growth in aquaculture production, mainly prawns, is likely to lead to lower crustacean prices and this will boost demand for crustaceans and fish. Crustacean consumption at the household level in particular should grow strongly. The implications of this development are unlikely to favour Australian exporters on account of their limited ability to compete with the aquaculture product at the retail level. Further work is needed to examine the potential for differentiating Australian prawns from cultured prawns as a means of reducing the impact of the increased aquaculture production on the Australian industry.

The aim of this paper was to identify the broad relationships between seafood and meat products in Japan. Additional work is being undertaken to further disaggregate the seafood categories in order to obtain a clearer understanding of the implications of changes in the Japanese market for the Australian seafood industry.

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Appendix A

RESULTS FROM THE AIDS MODELLING

a) Aggregate Meat System

NONLINEAR SUR SUMMARY OF RESIDUAL ERRORS

EQUATION	DF MODEL	DF ERROR	SSE	MSE	ROOT MSE	R-SQUARE
SHAREB	2.67	19.33	.00257	.00013	0.0115	0.9428
SHAREC	2.67	19.33	.00556	.00029	0.0170	0.0131
SHAREP	2.67	19.33	.00393	.00020	0.0143	0.4019
SHARESF	7	15	0.0130	00087	0.0295	0.6900

NONLINEAR SUR PARAMETER ESTIMATES

PARAMETER	ESTIMATE	APPROX. STD ERROR	'T' RATIO	APPROX. PROB>T
C10	0.49007	0.29006	1.69	0.1094
C11	0.04120	0.03001	1.37	0.1876
C12	-0.05452	0.02302	-2.37	0.0293
C13	0.00502	0.02072	0.24	0.8112
C1Y	-0.08621	0.07629	-1.13	0.2742
C1D2	0.00630	0.00201	3.13	0.0061
C20	0.62267	0.40233	1.55	0.1401
C22	0.04732	0.03744	1.26	0.2234
C23	-0.05246	0.02563	-2.05	0.0556
C2Y	-0.10157	0.10731	-0.95	0.3571
C2D2	0.00178	0.00281	0.63	0.5348
C30	0.05683	0.33220	0.17	0.8662
C33	0.07343	0.02509	2.93	0.0094
C3Y	0.04008	0.08938	0.45	0.6595
C3D2	-0.00182	0.00238	-0.76	0.4548

NUMBER OF OBSERVATIONS		STATISTICS FOR SYSTEM	
USED	22	OBJECTIVE	2.10409
MISSING	0	OBJECTIVE*N	46.29000

b)<u>Household Meat System</u>

NONLINEAR SUR SUMMARY OF RESIDUAL ERRORS

EQUATION	DF MODEL	DF ERROR	SSE	MSE	ROOT MSE	R-SQUARE
SHAREB	3.67	76.33	0.00285	3.73E-05	0.00611	0.7902
SHAREC	3.67	76.33	0.00190	2.49E-05	0.00499	0.7599
SHAREP	3.67	76.33	0.00575	7.53E-05	0.00868	0.8981
SHARESF	10	70	0.01963	0.000280	0.01674	0.8712

NONLINEAR SUR PARAMETER ESTIMATES

PARAMETER	ESTIMATE	APPROX. STD ERROR	'T' RATIO	APPROX. PROB>T
C10	0.02067	0.03413	0.61	0.5467
C11	-0.03704	0.02985	-1.24	0.2186
C12	-0.00491	0.01806	-0.27	0.7864
C13	0.00563	0.01847	0.30	0.7614
C1Y	0.06740	0.00885	7.61	0.0001
C1D1	-8.38E-04	0.00015	-5.60	0.0001
C1D2	0.00776	0.00129	6.03	0.0001
C1D3	-8.32E-05	2.52E-05	-3.30	0.0015
C20	0.09016	0.03063	2.94	0.0043
C22	0.04700	0.03735	1.26	0.2122
C23	-0.01080	0.02726	-0.40	0.6933
C2Y	0.01419	0.00715	1.98	0.0510
C2D1	-4.86E-04	0.00012	-4.03	0.0001
C2D2	0.00433	0.00114	3.80	0.0003
C2D3	-7.39E-05	2.03E-05	-3.64	0.0001
C30	0.16141	0.03949	4.09	0.0001
C33	0.09339	0.02788	3.35	0.0013
C3Y	0.03691	0.01219	3.03	0.0034
C3D1	-0.00200	0.00021	-9.73	0.0001
C3D2	0.00289	0.00177	1.63	0.1068
C3D3	-7.66E-05	3.46E-05	-2.21	0.0301

NUMBER OF OBSERVATIONS		STATISTICS FOR SYSTEM	
USED	80	OBJECTIVE	2.76899
MISSING	0	OBJECTIVE*N	221.52
SUM OF WEIGHTS	79.7000		

c)<u>Aggregate Seafood System</u>

NONLINEAR SUR SUMMARY OF RESIDUAL ERRORS

EQUATION	DF MODEL	DF ERROR	SSE	MSE	ROOT MSE	R-SQUARE
SHAREPLC	2.33	19.67	0.001576	8.01E-05	0.00895	0.9621
SHARET	2.33	19.67	0.003003	0.00015	0.01236	0.9291
SHAREF	4.33	17.67	0.003219	0.00018	0.01350	0.9791

NONLINEAR SUR PARAMETER ESTIMATES

PARAMETER	ESTIMATE	APPROX. STD ERROR	'T' RATIO	APPROX. PROB>T
B10	-0.24136	0.21170	-1.14	0.2684
B11	0.12218	0.02355	5.19	0.0001
B12	-0.03144	0.01642	-1.92	0.0706
B1Y	0.09116	0.06139	1.48	0.1539
B1D2	0.00314	0.00067	4.68	0.0002
B20	0.67009	0.29251	2.29	0.0336
B22	0.10656	0.02116	5.04	0.0001
B2Y	-0.12925	0.08552	-1.51	0.1471
B2D2	0.00504	0.00063	7.98	0.0001

NUMBER OF OBSERVATIONS		STATISTICS FOR SYSTEM	
USED	22	OBJECTIVE	1.78788
MISSING	0	OBJECTIVE*N	39.33333

d)<u>Household Seafood System</u>

NONLINEAR SUR SUMMARY OF RESIDUAL ERRORS

EQUATION	DF MODEL	DF ERROR	SSE	MSE	ROOT MSE	R-SQUARE
SHAREPLC	3.33	76.67	0.0027470	3.58E-05	0.00599	0.7460
SHARET	3.33	76.67	0.0029380	3.83E-05	0.006190	0.3956
SHAREF	6.33	73.67	0.0042854	5.82E-05	0.007627	0.6864

NONLINEAR SUR PARAMETER ESTIMATES

PARAMETER	ESTIMATE	APPROX. STD ERROR	'T' RATIO	APPROX. PROB>T
B10	0.18894	0.02436	7.76	0.0001
B11	-0.21891	0.02511	-8.72	0.0001
B12	0.05239	0.01953	2.68	0.0090
B1Y	0.00039	0.00931	0.04	0.9671
B1D1	-1.39E-04	0.00017	-0.80	0.4256
B1D2	0.00328	0.00133	2.46	0.0162
B1D3	-5.59E-05	2.50E-05	-2.23	0.0287
B20	0.03182	0.02557	1.24	0.2172
B22	-0.03836	0.02427	-1.58	0.1182
B2Y	0.02454	0.00958	2.57	0.0123
B2D1	8.06E-05	0.00018	0.45	0.6516
B2D2	-6.97E-04	0.00136	-0.51	0.6098
B2D3	-2.42E-05	2.58E-05	-0.94	0.3500

NUMBER OF OBSERVATIONS
USED 80
MISSING 0
SUM OF WEIGHTS 79.7000

STATISTICS FOR SYSTEM
OBJECTIVE 1.90595
OBJECTIVE*N 152.48

Appendix B

RESULTS FROM THE EXPENDITURE REGRESSIONS

a) Aggregate Expenditure

DEP VARIABLE: EXP

ANALYSIS OF VARIANCE

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB>F
MODEL	4	6.62856002	1.65714	2467.104	0.0001
ERROR	15	0.01007541	0.00067		
C TOTAL	19	6.63863543			

ROOT MSE	0.02591707	R-SQUARE	0.9985
DEP MEAN	9.705114	ADJ R-SQ	0.9981
C.V.	0.2670455		

PARAME .ER ESTIMATES

VARIABLE	DF	PARAMETER ESTIMATE	STANDARD ERROR	T FOR H0: PARAMETER=0	PROB > T
INTERCEP	1	-2.40980215	2.29539672	-1.050	0.3104
OTH	1	-0.23112693	0.17465379	-1.323	0.2055
PRICE	1	0.76774388	0.17107089	4.488	0.0004
Y	1	0.76662496	0.26507287	2.892	0.0112
TIME	1	-0.01318351	0.01021459	-1.291	0.2164

DURBIN-WATSON D 2.054
(FOR NUMBER OF OBS.) 20
1ST ORDER AUTOCORRELATION -0.035

b) Household Expenditure

DEP VARIABLE: EXP

ANALYSIS OF VARIANCE

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB>F
MODEL	13	2.41375143	0.185673	163.996	0.0001
ERROR	56	0.06340231	0.001132		
C TOTAL	69	2.47715375			

ROOT MSE	0.03364794	R-SQUARE	0.9744
DEP MEAN	10.59571	ADJ SQ	0.9685
C.V.	0.317562		

PARAMETER ESTIMATES

VARIABLE	DF	PARAMETER ESTIMATE	STANDARD ERROR	T FOR H0: PARAMETER=0	PROB > T
INTERCEP	1	6.39953375	1.89994727	3.368	0.0014
OTH	1	0.02412323	0.25022354	0.096	0.9235
PRICE	1	0.61617803	0.20492043	3.007	0.0039
Y	1	-0.02990262	0.13067757	-0.229	0.8198
TIME	1	-0.00338164	0.00721423	-0.469	0.6411
A1	1	-0.37309296	0.04614034	-8.086	0.0001
A2	1	-0.27371424	0.03719257	-7.359	0.0001
A3	1	-0.22604771	0.02864442	-7.892	0.0001
A4	1	-0.11513931	0.02092324	-5.503	0.0001
A6	1	0.08159462	0.02061051	3.959	0.0002
A7	1	0.14273603	0.02367411	6.029	0.0001
A8	1	0.15866633	0.01814327	8.745	0.0001
A9	1	0.14724100	0.02985439	4.932	0.0001
A10	1	0.07627233	0.04422010	1.725	0.0901

DURBIN-WATSON D 1.607
(FOR NUMBER OF OBS.) 70
1ST ORDER AUTOCORRELATION 0.193

Appendix C

DERIVATION OF OWN-PRICE ELASTICITIES

$$\varepsilon_{ii} = \frac{\partial q_i}{\partial p_i} \cdot \frac{p_i}{q_i}$$

where ε_{ii} = own-price elasticity,
p_i = price , and
q_i = consumption.

$$\text{Now} \quad w_i = \frac{p_i q_i}{E}, \text{ so } q_i = \frac{w_i E}{p_i}$$

where w_i = the budget share of good i, and
E = aggregate meat and seafood expenditure,

(1) $$\text{and} \quad \varepsilon_{ii} = \frac{\partial\left(\frac{w_i E}{p_i}\right)}{\partial p_i} \cdot \frac{p_i}{q_i}$$

$$\text{Now} \quad \frac{\partial\left(\frac{w_i E}{p_i}\right)}{\partial p_i} = \frac{p_i \frac{\partial(w_i E)}{\partial p_i} - w_i E \frac{\partial p_i}{p_i}}{p_i^2}$$

$$= \frac{p_i\left[E \frac{\partial w_i}{\partial p_i} + w_i \frac{\partial E}{\partial p_i}\right] - w_i E}{p_i^2}$$

$$= \frac{E}{p_i} \cdot \frac{\partial w_i}{\partial p_i} + \frac{w_i}{p_i} \cdot \frac{\partial E}{\partial p_i} - \frac{w_i E}{p_i^2}$$

(2) $$\text{and so} \quad \frac{\partial\left(\frac{w_i E}{p_i}\right)}{\partial p_i} \cdot \frac{p_i}{q_i} = \frac{E p_i}{w_i E} \cdot \frac{\partial w_i}{\partial p_i} + \frac{w_i p_i}{w_i E} \cdot \frac{\partial E}{\partial p_i} - \frac{w_i E}{p_i} \cdot \frac{p_i}{w_i E}$$

Recalling that $q_i = \dfrac{w_i E}{p_i}$, equation (2) may be rewritten as

$$\frac{\partial\left(\frac{w_i E}{p_i}\right)}{\partial p_i}.\frac{p_i}{q_i} = \frac{Ep_i}{w_i E}.\frac{\partial w_i}{\partial p_i} + \frac{w_i p_i}{w_i E}.\frac{\partial E}{\partial p_i} - \frac{w_i E}{p_i}.\frac{p_i}{w_i E}$$

$$= \frac{p_i}{w_i}.\frac{\partial w_i}{\partial p_i} + \frac{p_i}{E}.\frac{\partial E}{\partial p_i} - 1$$

(3) $$= \frac{p_i}{w_i}.\frac{\partial w_i}{\partial p_i} + \begin{bmatrix}\text{expenditure elasticity} \\ \text{wrt } p_i\end{bmatrix} - 1$$

From the expenditure regressions,

$$\ln E = \alpha + b_1 \ln P_{oth} + b_2 \ln P^* + b_3 \ln Y + b_4 T$$
$$= \alpha + b_1 \ln P_{oth} + b_2 w_i \ln p_i + b_2 \Sigma w_j \ln p_j + b_3 \ln Y + b_4 T$$

where P_{oth} = an index to represent the price of foods other than meat and seafood,
P^* = Stone's price index used to represent the price of meat and seafood,
Y = income,
T = a time variable, and
α, b_1, b_2, b_3 and b_4 are parameters to be estimated.

So, $$\frac{\partial E}{\partial p_i}.\frac{p_i}{E} = b_2 w_i \,.$$

Substituting this into equation (3), then

(4) $$\varepsilon_{ii} = b_2 w_i + \frac{p_i}{w_i}.\frac{\partial w_i}{\partial p_i} - 1$$

From the AIDS model, $$w_i = \alpha_i + \Sigma\beta_{ij}\ln(p_j) + \delta_i \ln\frac{E}{p^*}$$

Rearranging this,

$$w_i = \alpha_i + \Sigma\beta_{ij}\ln p_j + \delta_i \ln E - \delta_i \ln p^*$$

and

$$\frac{\partial w_i}{\partial p_i} = \frac{\beta_{ii}}{p_i} + \delta_i \frac{\partial \ln E}{\partial p_i} - \delta_i \frac{\ln p^*}{\partial p_i}$$

$$= \frac{\beta_{ii}}{p_i} + \delta_i\left(\frac{\ln E}{\partial E}.\frac{\partial E}{\partial p_i}\right) - \delta_i\left(\frac{\ln p^*}{\partial p^*}.\frac{\partial p^*}{\partial p_i}\right)$$

$$= \frac{\beta_{ii}}{p_i} + \frac{\delta_i}{E}.b_2 w_i.\frac{E}{p_i} - \frac{\delta_i}{p^*}.\frac{\partial p^*}{\partial p_i}$$

Now $$\frac{\partial p^*}{\partial p_i} = w_i p_i^{wi-1}.\pi_{pj}^{wj}$$

$$= \frac{w_i p^*}{p_i}$$

So, $$\frac{\partial w_i}{\partial p_i} = \frac{\beta_{ii}}{p_i} + \frac{\delta_i}{p_i} b_2 w_i - \frac{\delta_i w_i}{p_i}$$

$$= \frac{1}{p_i}[\beta_{ii} + \delta_i b_2 w_i - \delta_i w_i]$$

and $$\frac{\partial w_i}{\partial p_i}.\frac{p_i}{w_i} = \frac{1}{p_i}[\beta_{ii} + \delta_i\, b_2 w_i - \delta_i w_i]\frac{p_i}{w_i}$$

$$= \frac{\beta_{ii}}{w_i} + \delta_i(b-1)$$

Substituting this into equation (4),

$$\varepsilon_{ii} = b_2 w_i + \frac{\beta_{ii}}{w_i} + \delta_i (b_2 - 1) - 1$$

where b_2 is the coefficient of $\ln P^*$ from the expenditure regressions,
β_{ii} is the own-price coefficient from the AIDS modelling, and
δ_i is the coefficient of $\ln\left(\frac{E}{P*}\right)$ from the AIDS modelling.

The cross-price elasticities are derived in a similar fashion, such that

$$\varepsilon_{ij} = \frac{\beta_{ij}}{w_i} + \frac{b_2 \delta_i w_j}{w_i} - \frac{\delta_i w_j}{w_i} + b_2 w_j$$

Appendix D

DERIVATION of AWAY FROM HOME ELASTICITIES

Elasticity of demand with respect to own price $= \frac{\partial Q}{\partial P} . \frac{P}{Q}$

$$= \frac{\partial H + \partial A}{\partial P} . \frac{P}{Q}$$

$$= \frac{\partial H}{\partial P} . \frac{P}{Q} + \frac{\partial A}{\partial P} . \frac{P}{Q}$$

$$= \frac{H}{Q}\left[\frac{\partial H}{\partial P} . \frac{P}{H}\right] + \frac{A}{Q}\left[\frac{\partial A}{\partial P} . \frac{P}{A}\right]$$

$$= \frac{H}{Q} \text{ household elasticity} + \frac{A}{Q} \text{ elasticity away from home}$$

So, $\frac{A}{Q}$ elasticity away from home = aggregate elasticity $- \frac{H}{Q}$. household elasticity

$$\therefore \begin{array}{c}\text{elasticity wrt price}\\ \text{away from home}\end{array} = \frac{Q}{A} . \begin{array}{c}\text{aggregate elasticity}\\ \text{wrt price}\end{array} - \frac{H}{A} \begin{array}{c}\text{household elasticity}\\ \text{wrt price}\end{array}$$

where Q, A and H represent the aggregate, away from home, and at home levels of consumption for each commodity at the 1986 levels.