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Demand for Meats in Japan

A Review and an Update of Elasticity Estimates

John H. Dyck

DEMAND FOR MEATS IN JAPAN: A REVIEW AND AN UPDATE OF ELASTICITY ESTIMATES.
By John H. Dyck, Agriculture and Trade Analysis Division, Economic Research
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ABSTRACT

Estimates of income, own-price, and cross-price elasticities of demand for
beef, pork, chicken meat, and fish are reviewed. The estimates differ in the
methods used to obtain them, in the data sources used, and in the periods that
they cover. Changes in the sizes of some income and price elasticities appear
to have occurred over time. Cross-price elasticity estimates have often been
not significantly different from zero, and those that have been reported are
often not in agreement with others. Use of aggregated fish consumption and of
a fish price index has been unsuccessful, whether in determining the demand
for fish or the demand for meats. Single-equation methods used to estimate
elasticities with updated data show that remarkably high elasticities of
demand for beef, pork, and chicken meat persist, and that most cross-price
elasticities cannot be estimated with confidence. A few interesting
cross-price elasticity estimates have emerged from previous demand system
work, and such an approach is recommended for future use.

Keywords: Japan, meats, beef, pork, chicken meat, fish, demand, elasticities

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INTRODUCTION

This report reviews information that has already been published about the elasticities of demand for meats and fish in Japan. It also presents a number of new, single-equation elasticity estimates that use the methods of previous studies with updated data.

The first section reviews the major sources of data. The next two sections summarize the scope and methods of previous studies, and a fourth section describes the estimation procedures used for this study. The fifth section compares the empirical results of the previous studies and those made for this study. The final section gives a summary of the most important results.

Japan has undergone dramatic economic growth in the twentieth century, and cultural changes of great proportions have followed in the wake of economic growth and participation in the global economy. One reason for studying the elasticities of demand in Japan is to see what happens to demand relationships when a country goes through such massive change. Despite cultural differences, the changes that have taken place in the diet of the Japanese people are indicators of what might happen in the rest of East Asia, and perhaps in the entire developing world. Another major reason for looking at parameters of demand for meats, such as elasticities, has to do with the difficult problems that face Japan's agricultural trade policies. Because the Japanese market for beef is heavily protected, and because the population and wealth of Japan are so large, there is a good deal of interest in examining what might happen if Japan were to liberalize its beef trade. Among the questions that analysts and forecasters face are the effect of changing prices of beef on the consumption of beef; the effect of changing prices of beef on the consumption of other meats, and thus on the derived demand for imported feeds used in producing other meats; the extent that economic growth in Japan will influence the consumption of beef and other meats; and the effect of changing feedstuff prices on consumption of meat. In addressing all of these questions, estimates of consumer response to price and income changes are required. This paper seeks to assemble and contrast a number of such estimates.

SOURCES OF DATA

Three major sources of data on Japanese food consumption exist. One is the Food Balance Sheets (FBS) prepared by Japan's Ministry of Agriculture, Forestry, and Fisheries (MAFF) to provide data that conform to the measurement

system devised by the Food and Agriculture Organization (FAO) (see, for example, Saxon, p. 4) 1/. The FBS are published annually in the <u>Statistical Yearbook</u> of the MAFF. This system relies on measuring the supplies, stocks, and disappearance of as many foods as possible. Human food consumption is calculated as the residual when production, net trade, changes in stocks, and nonfood uses have been accounted for. This residual is converted into consumption per person in kilograms and calories.

Two other major data sources are the results of household surveys done by the Statistics Bureau in Japan. Surveys have been conducted since 1925, with continuity of coverage and amount of detail increasingly strengthened since then. One survey is the Family Income and Expenditure Survey (FIES). It is conducted on a continuous basis, sampling about 8,000 households each month. Household expenditures are tracked for 6 months. The sample is different in each month because the selection of households is staggered.

Stratified sampling is done within each of Japan's prefectures. Selected results are published in Japanese and English for each month in the <u>Monthly Statistics of Japan</u>, and annual volumes present monthly results and 12-month averages by geographic area and type of household (Statistics Bureau, 1985, pp. 443-5). The tapes of the actual household data are not released.

The Statistics Bureau also conducts a National Survey of Family Income and Expenditure (NSFIE) every 5 years. The surveys began in 1959, and the latest were in 1979 and 1984. The 1979 survey sampled 53,000 households, with the chief aim of gathering more demographic detail about households for use in cross-section analysis. The results of the 1979 survey were published in seven volumes in Japanese and English (Statistics Bureau, 1981, pp. 25-6, and 527). Tapes of the household-level data are not available.

Each type of data has limitations and weaknesses. An obvious weakness in the FBS system is the fact that consumption is derived as a residual and, thus, is prone to all the errors made in measuring supplies, stocks, trade, and nonfood uses. With the FIES data, researchers know that total consumption was actually estimated by respondents and is not a residual figure.

Although similar knowledge does not exist for the FBS, the FBS estimates are nevertheless very useful. Saxon (p. 5) and Sanderson (pp. 46-7) both point out that food consumption is increasingly done away from home. The FIES data do not give details on what foods are eaten away from home, but the FBS data include all uses of a particular food, at or away from home.

The FBS data implicitly cover all households in Japan, while the FIES survey excludes many Japanese households. The FIES does not survey the following categories: one-person households (about 16 percent of households in 1980; Statistics Bureau, 1982); households whose primary income is from agriculture, forestry, or fishing (5.5 percent of households in 1982--the MAFF conducts a separate annual expenditure survey of these households); households selling food or lodging; households with more than four live-in employees; households whose head is absent; and households of foreigners. In all, about 25 percent of Japan's households are excluded.

1/ The ministry was referred to as the Ministry of Agriculture and Forestries (MAF) before 1978. All references to the ministry in this report are to MAFF, regardless of the date. Complete citations for all sources are listed in the Bibliography.

The population that the NSFIE samples is basically the same as that sampled by the FIES, except that nonstudent single-person households are included in the NSFIE sample. Although the detail about household circumstances is considerably greater than for the FIES, commodity detail in the NSFIE has not matched that of the FIES since the 1974 NSFIE survey, when data-gathering on individual fish and vegetable purchases was dropped.

Despite the problems just cited, the Government of Japan maintains a wealth of data on food consumption. There is a great deal of commodity detail, and the quality of the data is admired worldwide. These data can be and have been used in a variety of ways. The cross-section data of the FIES and NSFIE have several uses that differ in ease of access and in interpretation. The Statistics Bureau issues a number of descriptions and analyses of the data in its Annual Reports on the FIES. The FIES reports include Engel coefficients (food expenditures divided by total living expenditures) for a number of household classifications by month and by year. The reports also provide expenditure elasticities for many food items, obtained by linear regression of item expenditure on total living expenditures, using a cross section of average annual expenditures by each of 16 income groups. In other tables, with varying amounts of commodity detail, expenditures are listed for classifications that use a 5-way, a 10-way, or an 18-way division of households by income.

Readers can perform their own graphical or statistical analyses by using cross-section data on income groups or data on geographic areas. When this information is pooled for a number of years, it becomes a cross-section time series data set.

Researchers seeking time series data sets can use either the FBS quantity estimates or use the annual national average expenditures or quantities given by the FIES. While the FBS data may be preferable to the annual averages from the survey data for many purposes of commodity-oriented research, looking at both types of time series data is better than choosing just one. Several studies have used both types of data.

Economists studying food consumption need price as well as quantity information. The FIES collects expenditures and quantity consumed for most foods, and calculates an implicit price by dividing expenditures by quantity. Nominal retail prices for Tokyo for many foods are reported in the Japan Statistical Yearbook. The yearbook also lists consumer price indices for 12 food and beverage categories (including fish and shellfish, fresh fish and shellfish, meat, and milk products and eggs) for Japan and for Tokyo. For all Japan, the same information is also printed in the annual reports on the FIES. The price indices are of the Laspeyres type, evaluated at the quantities of the base period. The aggregation of individual goods' prices (which are collected in the Statistics Bureau's Retail Price Survey) into the 12 categories is made using expenditure share weights from the FIES in a base year (Statistics Bureau, 1982, p. 409).

PREVIOUS USES OF TIME SERIES DATA

Many studies have made estimates of the parameters of animal protein food demand in Japan in the last 20 years. Over 20 studies are discussed below, and they constitute most of the English-language as well as some of the most important Japanese-language studies. Several of these studies have employed

more than one estimation technique and, thus, arrived at more than one parameter estimate. In addition, there have been the regularly published expenditure elasticities estimated each year by the Statistics Bureau (printed in the FIES reports), and several studies by the MAFF to aid in its forecasting. Very useful summaries of research findings have appeared. Saxon (1975), in his report, explains research results of the MAFF that are not available in English. Prosser (1973) and Sanderson (1978) present and critically examine the research and forecasts of the MAFF as well as, in the case of Sanderson's book (pp. 26-52, especially 51-2), of the Food and Agriculture Organization, the Organization for Economic Cooperation and Development, and the U.S. Department of Agriculture. Hayami (1979, p. 345), Sawada (1980, p. 107), Coyle (1983, pp. 61-70), Longworth (1983, p. 277) and Williams (1985, p. 61) present tables that show elasticity estimates of several researchers. Coyle's tables show the greatest detail about the methods and data that underlie the estimates.

The estimates of income and price elasticity for beef, pork, chicken, and fish are presented in tabular form (see tables 4-6 and 8). However, presentation of these tables and comments on what the numerical results contribute to an understanding of present and future demand for food will be postponed until a brief outline of methodologies followed by the researchers is presented. The diversity of methods and data used by previous researchers makes a quick summary difficult. The lack of information about data in some of the more sophisticated econometric studies also makes evaluation difficult. However, the studies may be grouped according to their use of time series or cross section data, with the numerous time series studies further broken down according to the type of econometric technique used.

Single Equation, Time Series Estimation

Hayakawa used FIES annual averages of survey data as the quantity variables in time series analysis for the period 1956-64, Uchiyama used the averages for 1964-77, and the MAFF ran time series regressions with these data for several periods. Yuize (1966, pp. 3-6) used quarterly FIES data from 1957-62. Lee used annual averages from the MAFF farm household surveys, for 1951-62. Other researchers have estimated single equations using the FBS data or other data derived by a similar method. Nakayama used the MAFF's basic data to calculate his own food balance estimates, and he regressed calories per person on income, using log-linear equations, to estimate income elasticities. Other researchers have accepted published data and used quantities as the dependent variable. Kester, Lopez (in Coyle), and, evidently, Yamashita used FBS data directly. Kester looked at the period 1960-78, Yamashita at 1911-38 and 1951-69. Sanderson used dressed carcass weight, a wholesale rather than a retail quantity, for regressions for 1963-74. Crutchfield used landed catch weight and ex-vessel prices, both wholesale-level measurements, for his fish demand equation for 1955-79. Most researchers used log-linear, semilog, or linear equations, usually without discussion.

Simultaneous Equations Approach

Few researchers using single equations presented their research in terms of utility maximization theory or of a model of the market process. Yuize (1962) did try price-dependent as well as quantity-dependent equations, apparently only in search of significant substitution effects. Two dissertations, one by Filippello (Missouri, 1968) and the other by Rachman (Montana, 1974), tried to avoid the simultaneity bias that is inherent when quantity and price data are

used in time series. Both researchers used price-dependent demand equations and quantity-dependent supply equations with data of the FBS type to model a market process. Filippello used three-stage least squares estimation, and Rachman used two-stage least squares. Because of compromises that Filippello and Rachman were forced to make, their simultaneous systems imply a very restrictive form of supply-demand interaction in the market for meats, and this weakens the credibility of their results. Because their equations were price dependent, they obtained price flexibilities, rather than elasticities, so that comparisons with other studies' results are hard to make.

Williams constructed a simultaneous equation model in which parameters "were estimated by means of a nonlinear, truncated two-stage least squares (2SLS) procedure based on principal components" (p. 107). His behavioral equations for consumption of beef, pork, and chicken were quantity-dependent and linear in logs, so that they provide price elasticities that are readily compared with those from other studies, in contrast to Rachman and Filippello. Williams' cross price was a combination of substitutes' real prices. For example, in the case of beef, the pork price was weighted by the quantity share of pork in total pork and chicken consumed, and the chicken price was weighted analogously. The two weighted prices were added to become a composite price, which was then entered in regression as a single explanatory variable. The single cross-price coefficient obtained in regression was then divided arithmetically between pork and chicken to give cross-price elasticities of beef for those two meat prices. The method of division of the coefficient, in itself an elasticity because of the log-linear functional form, is not clear, but it seems that such a procedure is prone to bias if there is significant correlation between substitutes' prices. Because the most likely reason that the combined price had to be constructed in the first place is multicollinearity among the prices, such a correlation seems highly probable. Despite the problem of ascertaining cross-price elasticities, Williams' study did address the simultaneous equations bias and provided income and own-price elasticity estimates that benefited from the inclusion of cross-price information.

Incorporation of Lagged Effects

Both Filippello and Rachman included lagged variables in their models, and several other authors have also tried this. Yuize (1966, pp. 25-27), using quarterly average FBS-type data for 1957-62, calculated shortrun and longrun elasticities using a log-linear version of the partial adjustment model. In his 1979 article (p. 128), Yuize repeated his analysis with a linear equation on annual FBS data, 1956-76. Uchiyama, whose work is discussed below, also used the dependent variable, lagged one period, to capture a habit effect. Yamashita (Ph.D. dissertation, Minnesota, 1973), trying to measure an impact of changing tastes, used the sum of all previous periods' consumption as a variable in log-linear, quantity-dependent equations; her results were poor. Sasaki and Fukagawa's experiments with lagged effects are described below.

Principal Components Regression

Uchiyama sought a way around the high degree of multicollinearity that has prevented most of the researchers using single-equation techniques from finding reliable cross-price elasticity estimates. He used principal components regression, in which the X matrix of explanatory data is transformed into a matrix whose columns, called principal components, correspond in number to the original number of variables and contain

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information not from just one variable, but from linear combinations of all the original variables. These new variables, or principal components, are all mutually uncorrelated. This matrix allows the researcher to select a subset of columns--Uchiyama chose those associated with the largest characteristic roots of the X'X matrix--to be the explanatory variables in regression. Because a smaller number of variables is used, the regression is more likely to produce efficient parameter estimates, in the sense of having smaller variances, than ordinary regression is. After the regression, estimates of the parameter values of all the original variables are calculated from the values of the principal components parameter estimates. Unfortunately, the end result is a set of parameter estimates (for example, elasticities) that is biased. Although the variances of the estimates are smaller than those from an unrestricted, untransformed regression, the smaller variances must be traded off against the unknown degree of bias in the parameter estimates, and the bias could be large. Uchiyama's estimates are tied tightly to his sample and to his method of choosing principal components and, thus, have limited validity. Besides Uchiyama's use of habit effects and principal components, his study is notable for including household size as a variable. Its coefficient's value is negative for milk, chicken, pork, and beef, with the absolute value increasing from milk to beef. Williams also used a principal components method in his model.

Demand Systems

Yoshihara sought a method for estimating consumer demand that would be more theoretically consistent than single-equation methods. One of the two systems he chose, the indirect addilog system, was too difficult to estimate econometrically, but he had better success with the linear expenditure system (LES). Unfortunately, his pursuit of theoretical consistency led to a common weakness of the systems approach--his groups were too highly aggregated to be of practical significance. His parameter estimates for the 'primary commodities' group are not useful for analysis of food demand. However, Yoshihara's insistence that demand systems not impose income elasticities equal to 1, and his preference for the LES directly influenced the research of Sasaki and Saegusa. They looked at the demand for nine food groups and a nonfood category, using FIES averages for 1958-68. The authors sought to use two LES formulations, the Leser and Powell methods, and an amalgam of the two. Sasaki and Saegusa's empirical results were poor; in particular, a positive price elasticity of rice plagued all their estimates. The small size of their sample (11) was perhaps a major cause of their problems.

Sasaki (1982) and Sasaki and Fukagawa (1984) used methods similar to those of Sasaki and Saegusa with somewhat better results. They examined 11 food groups and 13 nonfood groups for 1951-61 (Sasaki and Fukagawa), 1950-60 (Sasaki), and 1961-70 (Sasaki), using FIES averages. Among the food groups were fish and meat. These groups were found to be gross complements for each other, as are all normal goods in an LES model. This implies that the income effect of a price change is greater than the substitution effect, or that the goods are also net complements. For later periods (1960-77 and 1958-80), the authors consolidated meat with milk and eggs, so that their elasticity estimates hold less interest for the purposes of this paper. Both studies experimented with ways of introducing a dynamic factor, a variable that would represent changing tastes over time. To do this, they tried current and lagged changes in income, the current rate of increase in income, and a time trend. Sasaki and Fukagawa found that these variables were often significant.

Like the studies of Sasaki and his coauthors, three other demand systems estimated for food in Japan relied on time series. Sato apparently applied a system of demand functions derived from a generalized constant elasticity-of-substitution utility function (1970). He constructed the "utility function numerically at a given point of time" (p. 12), using some prior information, and derived a system of demand functions linear in log differences. He applied the system to FIES annual averages for 1962-66 and comparable data for 1953-62. His results were changes in demand, which he illustrated by comparing 1953 with 1962 and 1962 with 1966 (p. 13), dividing up changes in consumption into income-related, price-related, and residual effects. Sato was chiefly interested in the residual effects, which reflect changes in taste, family size, and other factors. The residual effects for his animal protein foods group and for food away from home were positive in each of his comparisons, but generally negative for other foods. This tends to support the idea of a shift in tastes toward animal protein foods and eating outside the home. Sato also reported the results of a demand system derived from a quadratic utility function by Tsujimura in the sixties. Sato found the system to be unsatisfactory; cereals were estimated to be increasingly a luxury through the 1950's (p. 17).

Yuize and Sawada reported the results of estimation of Rotterdam models. Yuize (1979, p. 127) presented no details on his procedures, giving only the elasticity results for beef, pork, chicken, and fish. His data were from the FBS. Sawada used a version of the Rotterdam model that assumed block independence to estimate a subsystem of demand equations for animal protein foods. He used annual FIES averages for 1956-70 and calculated elasticities after imposing symmetry constraints. Although one of his chief goals was to find substitution relationships between fish and various meats, he could not get good results for his fish variable, even after imposing symmetry restrictions (pp. 104-8).

PREVIOUS USES OF CROSS-SECTION DATA

Cross-section studies of Japanese food consumption have been limited by the lack of public access to the household data collected by the Statistics Bureau. The Statistics Bureau performs linear regressions on yearly averages for income groups, but does not present any results of regression analysis directly on a cross section of households, which would be theoretically and statistically preferable to analysis of the averages. A Tokyo University group, under contract to the ERS, apparently used the household data from the 1959 NSFIE and the 1959 rural household expenditure survey of the MAFF for log-linear regressions of quantities consumed on total consumption expenditure. The Tokyo University group published results on rice, noodles, and bread (Institute for Agricultural Economic Research, pp. 74-6).

All other researchers used cross sections of group averages of one sort or another. In most cases, the grouping was by income. This was the case for Lee, who used an instrumental variable, log-linear method to try to reflect the effects of permanent income on farm households' consumption for each year, 1959-62. Sanderson (pp. 46-7) used a variety of functional forms to regress consumption of animal protein foods per person on disposable income per person for income group averages from the FIES for both 1965 and 1973.

A 1960 study by the MAFF regressed expenditures per person for a number of foods on total cash consumption expenditures per person, using income group

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data from monthly FIES surveys made in 1957. Using both semilog and log-linear functions, the study presented results for March, June, and November and for regressions on the 3-month averages of the dependent and independent variables. Among the foods studied were about 30 fish and shellfish types. Despite the age of the estimates, the study is useful, because it analyzes individual seafoods. The MAFF team also employed semilog and log-linear forms to regress consumption per person on disposable income per person for annual averages by income group from the 1951 farm household survey. Although there is little commodity detail and the results are very old, they do show regional patterns (pp. 167-200). Another MAFF study, issued in 1982, used FIES annual averages for income groups, had commodity coverage often comparable to the 1960 study, and used the same econometric techniques.

Yuize (1966) used the group averages from the surveys more creatively and extensively than other available studies. He used NSFIE results for 1959 that gave average consumption for households, cross-classified by income groups and household size. For each household size, he regressed consumption expenditures per person for various animal protein foods on average total consumption expenditures per household. Yuize then performed an analysis of covariance on the regression results from each household size group. On the basis of this analysis, he found no support for a difference in the Engel equations by household size (pp. 12-13). The same procedure was applied to income groups cross-classified by occupation (pp. 14-17), region (p. 17), and degree of urbanization (p. 20). This procedure showed considerable heterogeneity of results for occupation groups, but a regional difference only for dried fish, and a difference by degree of urbanization for meat, milk, and eggs. Yuize also performed a similar analysis on the MAFF farm household survey for 1960, and found large differences in Engel equations for animal protein foods by region. Because Yuize could use only 5 income groups in either survey, and his samples were for only 1 year, his conclusions should not be extended too readily.

Only one study was found, by Lee (pp. 656-7), that combined cross-section and time series data for estimation. He used annual averages by income group from the MAFF farm household surveys of 1959-62, with dummy variables in the slope coefficients, to see if income elasticities from his log-linear equations were different for the various years. He found that the income elasticities of fish and of the meat, milk, and eggs group were significantly larger in 1961 and 1962 than in 1959.

Both Lee (pp. 657-60) and Yuize (1966, pp. 3-6) used a technique called conditional regression. Because income is often collinear with prices, they estimated time series in which prices were the explanatory variables and consumption, with an income effect subtracted from it, was the dependent variable. They used income elasticities estimated from cross-section analysis as the income effect. This is an extreme form of mixed regression in which the income effects are treated as known parameters in the time series regression.

UPDATING THE ESTIMATES

Based on the review of past results, two approaches to updating and improving information about Japanese demand for protein foods seem useful. One is to use more recent data sets of the type used in the past, and apply the same single-equation techniques usually applied by other studies. Such updating would complement past studies and, using relatively easily accessed data and

simple estimation techniques, would be easy to perform. The other approach, encouraged by the apparent success of Sawada in finding cross-price elasticity estimates, is to use a demand systems model. This is attempted in another study by the author, using a new data set, and will not be discussed further here.

For the single-equation estimates, the log-linear form is used throughout. This form imposes a constant elasticity at all points and is not consistent with the adding up condition when demands for all goods are estimated this way. Despite these serious disadvantages, however, the log-linear form has been the most frequently used form in work on Japanese demand. Therefore, comparison of the new estimates with earlier published results is straightforward. In addition, calculation of elasticities without the log-linear specification is slightly harder and requires the choice of a specific point in the data at which to make the calculation.

Some of the previous work, by using simultaneous equation techniques, principal components regression, or dynamic specifications, may have reduced the bias or improved the accuracy of estimated elasticities. Some of these techniques impose additional problems even as they correct others, and each such piece of research has been different in method from all others, so that it is hard to compare the results from these studies with other results. These methods are not replicated with the updated data.

For regression results to be comparable with previous studies, some regressions must be made using the same data, the same dependent variables, and varying combinations of explanatory variables. In these cases of data mining, a t test for the significance of a coefficient is not appropriate. A more stringent test, the Scheffe test for simultaneous hypotheses, is appropriate and is calculated. The results of hypothesis testing are presented in tables 1-3.

Most of the time series studies cited have failed to report Durbin-Watson statistics or other evidence of autocorrelated error terms, and have not, apparently, attempted to correct a regression for autocorrelation. Autocorrelation of error terms results in inefficient ordinary least squares (OLS) estimates of parameters (that is, estimates that are not as accurate as possible). Also, estimates of standard errors are biased, so that significance tests are weakened. When Durbin-Watson statistics indicate that first-order autocorrelation is a problem in the updated regressions, an adjusted regression using the Statistical Analysis System (SAS) procedure AUTOREG is run. Only those Autoreg regressions that appreciably changed the OLS estimates are reported in tables 1-3.

The general procedure in the updating is to use three data sets, two of which contain annual quantity data through 1983. These data sets, from the FBS and the FIES, are the same as those used in most previous studies, except that they include more recent data. When quantities consumed per person come from the FBS, income per person is defined as National Income per person, and prices are retail prices. Income and prices are deflated by the author, using the Consumer Price Index (CPI) for all goods. The FIES data set contains both quantities and prices. When the FIES data are used, either National Income per person or total living expenditures per person is used as the variable representing income per person. All income and price variables in the FIES data are divided by the CPI for all goods.

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Table 1--Estimates of price and income elasticities for beef

Data source	Period	Durbin-Watson Statistic	R^2 adjusted	Price elasticities				Income	
				Beef	Pork	Chicken	Fresh fish & shellfish	Elasticity	Variable
1. FBS	1967–83	.77	.90	−.84 (.40)				2.13s (.19)	Inc
		AR		−.78 (.40)				1.94s (.25)	Inc
2. FBS	1967–75	2.17	.91	−.47 (.40)				1.63t (.18)	Inc
3. FBS	1975–83	1.40	.89	−.75 (.57)				2.45t (1.00)	Inc
		AR		−.67 (.58)				2.62t (1.01)	Inc
4. FBS	1967–83	1.31	.94	−.31 (.35)	−.60s (.19)			1.73s (.19)	Inc
5. FBS	1971–83	1.18	.93	−.56 (.34)	.37 (.32)	−.01 (.33)	1.15t (.41)	.72 (.51)	Inc
6. FIES	1963–83	.36	.71	−1.82t (.34)				1.07t (.15)	Inc
7. FIES	1967–83	.66	.86	−.97 (.33)				1.33s (.13)	Inc
		AR		−1.04s (.28)				1.09s (.16)	Inc
8. FIES	1967–83	1.72	.93	−.96t (.23)				1.38t (.10)	Exp
9. FIES	1967–75	1.87	.80	−.46 (.38)				.87t (.17)	Inc
10. FIES	1967–75	2.51	.85	−.65 (.36)				1.05t (.18)	Exp
		AR		−.77t (.34)				1.12t (.16)	Exp
11. FIES	1975–83	2.17	.94	−.62t (.31)				1.40t (.37)	Inc
12. FIES	1975–83	1.67	.91	−.53 (.51)				1.61t (.66)	Exp
13. FIES	1967–83	1.37	.92	−.35 (.31)	−.53s (.15)			.91s (.16)	Inc
14. FIES	1967–83	1.65	.94	.01 (.29)	−.03 (.23)	−.62 (.24)		.52 (.20)	Inc
15. FIES	1967–83	3.22	.98	−.14 (.17)	−.04 (.13)	−.58s (.13)	.88s (.17)	−.32 (.20)	Inc

Notes: Standard errors in parentheses. Inc = National Income/person. Exp = Total living expenditures, FIES. AR = Estimate using the Autoreg procedure of SAS, nlag=1.

s and t: These refer to tests of hypotheses. Two sets of equations involve several different hypotheses about coefficients of the same variables, and for the same time periods. One set is equations 1 and 4 above; the other is equations 7, 13, 14, and 15. For these equations, a Scheffe test is appropriate, because several hypotheses are tested simultaneously. Those coefficient estimates significant at the .95 level using a Scheffe test are marked with an s. The null hypothesis is that the coefficients are 0.

The coefficient estimates of the other equations are tested using a one-tailed t test (at the .95 level) of the null hypothesis that the coefficients are 0, except for cross prices, when a two-tailed t test is used. Significant coefficients are marked with a t.

Table 2—Estimates of price and income elasticities for pork

Data source	Period	Durbin-Watson Statistic	R^2 adjusted	Price elasticities				Income	
				Pork	Beef	Chicken	Fresh fish & shellfish	Elasticity	Variable
1. FBS	1967-83	.67	.89	-.99s (.19)				1.03s (.22)	Inc
		AR		-.71s (.20)				1.00s (.23)	Inc
2. FBS	1967-75	1.09	.77	-.86t (.42)				.81t (.19)	Inc
		AR		-.68 (.41)				.81t (.22)	Inc
3. FBS	1975-83	2.85	.86	-.31 (.35)				1.88 (1.25)	Inc
		AR		-.31 (.38)				1.88 (1.37)	Inc
4. FBS	1967-83	1.52	.94	-1.26s (.17)	1.04s (.31)			.94s (.17)	Inc
5. FBS	1971-83	2.58	.98	-.33 (.21)	.36 (.22)	-.16 (.22)	1.26 (.26)	1.16 (.33)	Inc
6. FIES	1963-83	.66	.96	-.38t (.15)				1.17t (.08)	Inc
7. FIES	1967-83	.45	.89	-.43 (.15)				.97s (.14)	Inc
8. FIES	1967-83	.99	.95	-.22t (.11)				1.17t (.11)	Exp
		AR		-.27t (.13)				1.05t (.13)	Exp
9. FIES	1967-75	1.03	.88	-1.10t (.38)				.88t (.13)	Inc
		AR		-.96t (.39)				.89t (.16)	Inc
10. FIES	1967-75	2.36	.94	-.58t (.29)				1.07t (.11)	Exp
11. FIES	1975-83	1.34	.73	-.27 (.22)				.13 (.66)	Inc
		AR		-.30 (.20)				.09 (.58)	Inc
12. FIES	1975-83	1.69	.74	-.38t (.17)				-.24 (.56)	Exp
13. FIES	1967-83	1.14	.94	-.72s (.13)	.97s (.26)			.66s (.13)	Inc
14. FIES	1967-83	1.34	.94	-.54 (.26)	1.10s (.30)	-.22 (.24)		.52 (.20)	Inc
15. FIES	1967-83	2.13	.99	-.56s (.11)	.94s (.15)	-.18 (.12)	.94s (.15)	.39 (.17)	Inc
16. FIES	1967-83	2.50	.98	-.50t (.13)	1.03t (.16)	-.04 (.13)	.63t (.11) (whale)	-.14 (.16)	Inc

Notes: Standard errors in parentheses. Inc = National Income/person. Exp = Total living expenditures. AR = Estimate using the Autoreg procedure of SAS, nlag=1.

s and t: These refer to tests of hypotheses. Two sets of equations involve several different hypotheses about coefficients of the same variables, and for the same time periods. One set is equations 1 and 4 above; the other is equations 7, 13, 14, and 15. For these equations, a Scheffe test is appropriate, because several hypotheses are tested simultaneously. Those coefficient estimates significant at the .95 level using a Scheffe test are marked with an s. The null hypothesis is that the coefficients are 0.

The coefficient estimates of the other equations are tested using a one-tailed t test (at the .95 level) of the null hypothesis that the coefficients are 0, except for cross prices, when a two-tailed t test is used. Significant coefficients are marked with a t.

Table 3--Estimates of price and income elasticities for chicken

Data source	Period	Durbin-Watson Statistic	R² adjusted	Price elasticities				Income	
				Chicken	Beef	Pork	Fresh fish & shellfish	Elasticity	Variable
1. FBS	1971-83	1.31	.91	-1.04 (.21)				1.21 (.59)	Inc
		AR		-.95 (.23)				1.29 (.58)	Inc
2. FBS	1971-83	1.28	.90	-1.01 (.24)	-.12 (.31)			1.24 (.62)	Inc
3. FBS	1971-83	1.04	.92	-.73 (.32)		-.38 (.30)		1.08 (.58)	Inc
4. FBS	1971-83	1.08	.91	-.68 (.35)	.20 (.39)	-.51 (.41)		.98 (.64)	Inc
5. FBS	1971-83	1.23	.97	-.21 (.22)	-.44 (.19)		1.35 (.30)	1.54 (.35)	Inc
6. FBS	1971-83	1.45	.97	-.07 (.23)		-.45 (.17)	1.16 (.26)	1.24 (.33)	Inc
7. FBS	1971-83	1.40	.97	-.06 (.24)	-.23 (.24)	-.30 (.23)	1.28 (.29)	1.37 (.36)	Inc
8. FIES	1963-83	.80	.98	-.61t (.13)				1.33t (.11)	Inc
9. FIES	1967-83	1.00	.96	-.72s (.12)				1.07s (.17)	Inc
		AR		-.61 (.16)				1.10s (.20)	Inc
10. FIES	1967-83	1.80	.97	-.56t (.11)				1.29t (.15)	Exp
11. FIES	1967-75	1.37		-1.78t (.51)				.53t (.23)	Inc
		AR		-1.69t (.53)				.58t (.24)	Inc
12. FIES	1967-75	2.97	.97	-1.52t (.55)				.72t (.27)	Exp
		AR		-1.28t (.45)				.83t (.22)	Exp
13. FIES	1975-83	2.51	.94	-.06 (.18)				2.28t (.65)	Inc
		AR		-.11 (.19)				2.13t (.68)	Inc
14. FIES	1975-83	1.26	.93	0 (.24)				2.72t (.93)	Exp
		AR		.04 (.22)				2.82t (.86)	Exp
15. FIES	1967-83	1.67	.97	-.96s (.15)	.75 (.33)			.71 (.21)	Inc
16. FIES	1967-83	.86	.96	-.52 (.27)		-.25 (.30)		1.13s (.18)	Inc
17. FIES	1967-83	1.47	.97	-.80 (.28)	.72 (.34)	-.19 (.26)		.77 (.23)	Inc
18. FIES	1967-83	1.52	.97	-.75s (.11)			.78 (.34)	.26 (.38)	Inc

Notes: Standard errors in parentheses. Inc = National Income/person. Exp = Total living expenditures, FIES. AR = Estimate using the Autoreg procedure of SAS, nlag=1.

s and t: These refer to tests of hypotheses. Two sets of equations involve several different hypotheses about coefficients of the same variables, and for the same time periods. One set is equations 1 through 7 above; the other is equations 9 and 15-18. For these equations, a Scheffe test is appropriate, because several hypotheses are tested simultaneously. Those coefficient estimates significant at the .95 level using a Scheffe test are marked with an s. The null hypothesis is that the coefficients are 0.

The coefficient estimates of the other equations are tested using a one-tailed t test (at the .95 level) of the null hypothesis that the coefficients are 0, except for cross prices, when a two-tailed t test is used. Significant coefficients are marked with a t.

Because expenditures on protein foods are used in calculating total living expenditures and total expenditures are used as an explanatory variable, the quantity consumed appears not only on the left side of the equation but also on the right side as part of total living expenditures. This may bias OLS estimates of the parameters. Equations that use National Income per person do not suffer from this bias. National Income per person, however, is not as good a representation of income per person as are total living expenditures obtained from a household survey, so that there is some reason to expect better results when total living expenditures are used. The GNP deflator and the CPI have shown different trends in part of the period analyzed, and, thus, the CPI is not adequate as a deflator to convert nominal national income accounts data to real levels. 2/ Another source of bias is introduced by using the CPI numbers to deflate prices. The indices should have been recalculated so that the price of the meat was excluded from them. The small weight of the individual meats in the calculation of the CPI for Japan may mean that this bias will be small.

Estimates are made for both data sets for the period 1967-83. In order to have some evidence about changes in elasticities within this period, many of the regressions are also made for the periods 1967-75 and 1975-83.

In addition to the time series estimates, cross-section estimates are made using a third data set. This data set contains information on group averages for 18 income groups in the 1979 NSFIE. The lowest and the highest income groups are excluded, leaving 16 groups. In contrast to the FIES, incomes (rather than expenditures) are reported in the NSFIE and are used in these regressions.

The results of the present study's regressions are presented in tables 1-3. No effort was made to update estimates for fish because that category seems to be too diverse. The results are also presented in a series of small tables that juxtapose the earlier estimates with current estimates from tables 1-3 that are most directly comparable. The most important outcomes of the comparisons and the updating are summarized in the last section.

COMPARISON OF ESTIMATES

The preceding sections have discussed the data and methods of a number of earlier studies, and have outlined the methods used by this study to provide an update of some of those studies. Sections below compare the results of earlier studies and the update on a commodity basis, discussing first income elasticities, then own-price elasticities, and finally cross-price elasticities.

Income Elasticities

Time Series Evidence on Beef

Income elasticities of demand for beef are given in table 4, and they range from a low of 0.84 (Hayakawa, using FIES data for 1957-64) to a high of 2.56 (Sanderson, using a time series of FBS data, 1963-74, including the price of chicken). Beef in Japan is a normal good, and the real question is whether or

2/ This point was brought to the writer's attention by Professor Hiroshi Mori in a personal communication.

Table 4--Beef: Income and price effects estimated by previous studies

Author, publication date, and period	Elasticity		Type of equation	Data		Notes
	Income	Own price		Time series	Cross section	
Filippello, 1968:						
1953-64			3SLS, ln-ln	FBS	--	Income flexibility is 0.76 and own-price flexibility is -0.60.
Hayakawa, 1966:						
1957-64	.84	n.s.	ln-ln	FIES	--	
Kester, 1980:						
1960-70	1.38	-.99	linear	FBS	--	Equation includes the price of pork.
Lopez, 1981 (Coyle):						
1965-79	1.74	-1.27	ln-ln	FBS	--	
MAFF 1/:						
1960:						
1957	.69	--	ln-ln	--	FIES	
	.73	--	semiln	--	FIES	
1973 and 1974 (Saxon):						
1955-64	1.1	-.96	ln-ln	FIES	--	
1960-69	1.02	-1.82	ln-ln	FIES	--	
1963-72	1.6	-1.93	ln-ln	FBS	--	
	1.17	-1.90	ln-ln	FIES	--	
	1.17	-1.93	ln-ln	FIES	--	Equation includes price of pork.
	1.06	-1.91	ln-ln	FIES	--	Equation includes price of chicken.
	1.16	-1.93	ln-ln	FIES	--	Equation includes price of pork and chicken.
	.98	--	ln-ln	--	FIES	
1982:						
1963	1.31	--	ln-ln	--	FIES	
1963-72	1.17	-1.87	ln-ln	FIES	--	
	1.14	-1.83	semiln	FIES	--	Elasticity evaluated at the means of the data.
	1.07	-1.72	semiln	FIES	--	Elasticity evaluated at 1972 data.
	1.19	-1.92	ln-ln	FIES	--	Equation includes price of pork.
	1.15	-1.86	semiln	FIES	--	Equation includes price of pork. Elasticity evaluated at the mean of the data.
	1.07	-1.74	semiln	FIES	--	Equation includes price of pork. Elasticity evaluated at 1972 data.
	1.14	-1.87	ln-ln	FIES	--	Equation includes price of chicken.
	1.18	-1.82	semiln	FIES	--	Equation includes price of chicken. Elasticity evaluated at the mean of the data.
	1.10	-1.71	semiln	FIES	--	Equation includes price of chicken. Elasticity evaluated at 1972 data.

See notes at end of table.   Continued--

Table 4--Beef: Income and price effects estimated by previous studies--Continued

Author, publication date, and period	Elasticity		Type of equation	Data		Notes
	Income	Own price		Time series	Cross section	

Author, publication date, and period	Income	Own price	Type of equation	Time series	Cross section	Notes
MAFF--Continued						
1982:						
1963-81	1.40	-1.73	ln-ln	FIES	--	
	1.37	-1.67	semiln	FIES	--	Elasticity evaluated at the mean of the data.
	1.08	-1.31	semiln	FIES	--	Elasticity evaluated at 1981 data.
	1.37	-1.70	ln-ln	FIES	--	Equation includes price of pork.
	1.25	-1.56	semiln	FIES	--	Equation includes price of pork. Elasticity evaluated at the mean of the data.
	.97	-1.21	semiln	FIES	--	Equation includes price of pork. Elasticity evaluated at 1981 data.
	1.43	-1.74	ln-ln	FIES	--	Equation includes price of chicken.
	1.16	-1.53	semiln	FIES	--	Equation includes price of chicken. Elasticity evaluated at the mean of the data.
	.90	-1.19	semiln	FIES	--	Equation includes price of chicken. Elasticity evaluated at 1981 data.
1964-73	1.18	-1.68	ln-ln	FIES	--	
1965	1.16	--	ln-ln	--	FIES	
1970	1.02	--	ln-ln	--	FIES	
1972-81	1.64	-.96	ln-ln	FIES	--	
	1.63	-.94	semiln	FIES	--	Elasticity evaluated at the mean of the data.
	1.41	-.81	semiln	FIES	--	Elasticity evaluated at 1981 data.
	1.85	-1.08	ln-ln	FIES	--	Equation includes price of pork.
	1.77	-1.02	semiln	FIES	--	Equation includes price of pork. Elasticity evaluated at the mean of the data.
	1.54	-.88	semiln	FIES	--	Equation includes price of pork. Elasticity evaluated at 1981 data.
	2.01	-1.14	ln-ln	FIES	--	Equation includes price of chicken.
	1.83	-1.03	semiln	FIES	--	Equation includes price of chicken. Elasticity evaluated at the mean of the data.
	1.58	-.89	semiln	FIES	--	Equation includes price of chicken. Elasticity evaluated at 1981 data.
1973	.89	--	ln-ln	--	FIES	
1975	.89	--	ln-ln	--	FIES	
1979	.89	--	ln-ln	--	FIES	
1981	.88	--	ln-ln	--	FIES	
	.90	--	semiln	--	FIES	Elasticity evaluated at the mean of weighted data.
	.90	--	ln-inv	--	FIES	Elasticity evaluated at the mean of weighted data.
Narita, 1986:						
1963-83	1.38	-.96	linear	FIES	--	
	1.42	-1.06	ln-ln	FIES	--	
	1.10	-1.10	ln-ln	FIES	--	Equation includes price of fish.

See notes at end of table.   Continued--

Table 4--Beef: Income and price effects estimated by previous studies--Continued

Author, publication date, and period	Elasticity		Type of equation	Data		Notes
	Income	Own price		Time series	Cross section	
Rachman, 1974:						
1953-70			2SLS, linear	Whole-sale	--	Income flexibility is 0.87 and own-price flexibility is -0.71
Sanderson, 1978:						
1965	.59	--	ln-ln	--	FIES	
1963-74	1.78	-2.18	linear	FBS	--	
	2.56	-2.22	linear	FBS	--	Equation includes price of chicken.
1973	1.06	--	semiln	--	FIES	
Sawada, 1980:						
1956-70	1.09	-1.38	Rotterdam	FIES	--	Equation includes prices of pork, chicken, and fish.
Uchiyama, 1979:						
1965-78	.89	-.45	ln-ln	FIES	--	Shortrun elasticity.
	2.45	-1.24	ln-ln	FIES	--	Longrun elasticity.
Williams, 1985:						
1962-82	1.65	-1.43	2SLS, ln-ln	FBS-type	--	Equation includes price of fish and a composite price of pork and chicken.
Yuize:						
1966:						
1951-60	1.02	n.s.	ln-ln	FIES	--	
	1.05	-.92	ln-ln	FIES	--	Equation includes price of pork.
1957-62, quarterly	--	-2.42	ln-lin	FIES	--	
1979:						
1956-71	.70	-.64	ln-ln	FBS	--	Shortrun elasticity.
	1.31	-1.20	ln-ln	FBS	--	Longrun elasticity.
1956-76	1.00	-1.10	Rotterdam	FBS	--	Equation includes prices of pork, chicken, and fish.
	.62	-.53	ln-ln	FBS	--	Shortrun elasticity.
	1.37	-1.17	ln-ln	FBS	--	Longrun elasticity.
	1.89	-1.70	linear	FBS	--	Elasticity evaluated at 1967 data.
1964-76	1.11	-1.44	ln-ln	FIES	--	Shortrun elasticity.
	1.33	-1.02	ln-ln	FBS	--	Shortrun elasticity.
	2.14	-2.77	ln-ln	FIES	--	Longrun elasticity.
	1.78	-1.37	ln-ln	FBS	--	Longrun elasticity.
1965-76	1.02	-1.16	ln-ln	FIES	--	Shortrun elasticity.
	2.10	-2.36	ln-ln	FIES	--	Longrun elasticity.
1966-76	.98	-.89	ln-ln	FIES	--	Shortrun elasticity.
	1.77	-1.61	ln-ln	FIES	--	Longrun elasticity.
1967-76	.81	-.67	ln-ln	FBS	--	Shortrun elasticity.
	1.49	-.78	ln-ln	FIES	--	Longrun elasticity.
	1.58	-1.30	ln-ln	FBS	--	Longrun elasticity.

n.s. = Not significant.   -- = Not applicable.
ln-ln : equation ln x = a + b(ln y).   linear : equation x = a + by.
semiln : equation x = a + b(ln y).   ln-inv : equation ln x = a + b(ln/y).
2SLS : two-stage least squares.   3SLS : three-stage least squares.
1/ Ministry of Agriculture, Forestry, and Fisheries.

not beef has been a luxury, with an income elasticity greater than 1. Among the time series results, only Hayakawa's result and the MAFF (1982) results for two 1963-81 specifications were under 1. Even the shortrun elasticities estimated by Uchiyama and Yuize (1979) were nearly 1, or greater.

The time series results have shown no clear trend over different periods. Yuize's 1979 estimates based on FBS data did not show a regular pattern. Both Williams (1985) and Lopez (1981, in Coyle), using FBS-type data that included recent years, found elasticity estimates that were as high as those of Kester, the MAFF, Sanderson, and Yuize (1979) on similar data for earlier years. Yuize's elasticities from FIES data for various periods showed a decline. Results for later years by the MAFF and Narita showed generally higher income elasticities than the results of Hayakawa, the MAFF, and Yuize for earlier years. For time series, an income elasticity between 1 and 2 is usually observed in most studies. This is remarkably high, and there seems to be no sign of decline.

The results from 15 equations estimated here (see table 1) support the hypothesis that beef is an income-elastic food, with the significant estimates ranging from 0.87 to 2.62. Equations using FBS data had higher elasticities than those from FIES data. This outcome lends credence to the conjecture that the FBS data, which include consumption away from home, should show greater response to income changes than the FIES data. Among the FIES results, three pairs of estimates differed only in the income variable. In each case, the elasticity estimate from the equation using expenditures was higher than that from the equation using National Income per person. The FBS results for 1975-83 had higher income elasticities than those for 1967-75. The FIES results did not show such a pattern, but there is no evidence from the present study to indicate a falling elasticity in recent years. The inclusion of cross prices did not generally lead to lower income elasticity estimates. The MAFF (1982) and present results provided a few hints that inclusion of a pork price may lower the estimated beef income elasticity. But the MAFF (1982) also presented results showing that inclusion of the chicken price raised beef income elasticities. Thus, although multicollinearity of the income and cross-price variables certainly exists, it cannot be assumed that a high beef income elasticity estimate, from an equation that has no cross prices, is biased upward.

Time Series Evidence on Pork

Income elasticity estimates for pork are given in table 5. They range between 0.57 (Yuize, with Rotterdam model results on FBS data for 1956-76) and 3.13 (Hayakawa with an FIES time series for 1957-64). This range exceeds that for beef estimates, both high and low. A number of comparable estimates showed a higher elasticity for pork than for beef. This was particularly true for earlier periods and for equations in which the price of chicken was the only cross price. Estimates for later periods generally indicated a higher elasticity for beef, both because beef income elasticities for later periods were especially high and because the time series estimates for pork income elasticities tended to decline over time. Studies whose data go well into the seventies, with the exception of that by Williams, estimate elasticities that range from 0.57 (Yuize, 1979, with FBS data, 1956-76) to 1.04 (Sanderson, with FBS-type data, 1963-74). There seems to be some evidence that the income elasticity of pork has fallen over time. This could be checked with more recent data. Meanwhile, the studies cited suggest that the income elasticity of pork lies between 0.5 and 1.5.

Table 5--Pork: Income and price effects estimated by previous studies

Author, publication date, and period	Elasticity		Type of equation	Data		Notes
	Income	Own-price		Time series	Cross section	
Filippello, 1968:						
1953-64			3SLS, ln-ln	FBS	--	Income flexibility is 0.62 and own-price flexibility is -0.60.
Hayakawa, 1966:						
1957-64	3.13	-2.19	ln-ln	FIES	--	
Kester, 1980:						
1960-69	1.16	-2.18	semiln	FBS	--	
1960-75	.85	-.77	linear	FBS	--	Equation includes the prices of beef and chicken.
Lopez, 1981 (Coyle):						
1965-79	1.25	-1.08	ln-ln	FBS	--	
MAFF 1/:						
1960 report:						
1957	1.01	--	semiln	--	FIES	Evaluated at the means of the data.
1973 and 1974 report (Saxon):						
1955-64	2.78	-1.83	ln-ln	FIES	--	
1960-69	2.54	-2.15	ln-ln	FIES	--	
1963-72	1.22	-1.61	ln-ln	FBS	--	
	1.53	-1.84	ln-ln	FIES	--	
	.84	-1.34	ln-ln	FIES	--	Equation includes price of beef.
	n.s	-1.56	ln-ln	FIES	--	Equation includes price of chicken.
	n.s	-1.05	ln-ln	FIES	--	Equation includes price of beef and chicken.
1964-73	1.46	-1.76	ln-ln	FIES	--	
1963	1.23	--	ln-ln		FIES	
1969	.75	--	ln-ln		FIES	
1973	.61	--	ln-ln		FIES	
1982 report:						
1963-72	1.59	-1.76	ln-ln	FIES	--	
	1.47	-1.38	semiln	FIES	--	Evaluated at the means of the data.
	1.07	-1.00	semiln	FIES	--	Evaluated at 1972 data.
	.95	-1.24	ln-ln	FIES	--	Equation includes the price of beef.
	1.11	-1.09	semiln	FIES	--	Equation includes the price of beef. Evaluated at the means of the data.
	.82	-.81	semiln	FIES	--	Equation includes the price of beef. Evaluated at 1972 data.
	2.81	-2.28	ln-ln	FIES	--	Equation includes price of chicken.
	2.35	-1.74	semiln	FIES	--	Equation includes price of chicken. Evaluated at the means of the data.
	1.74	-1.29	semiln	FIES	--	Equation includes price of chicken. Evaluated at 1972 data.

See notes at end of table.

Author, publication date, and period	Elasticity		Type of equation	Data		Notes
	Income	Own-price		Time series	Cross section	
MAFF--Continued						
1982:						
1963-81	1.61	n.s.	ln-ln	FIES	--	
	1.25	-.41	semiln	FIES	--	Evaluated at the means of the data.
	.91	-.30	semiln	FIES	--	Evaluated at 1981 data.
	.82	-.64	ln-ln	FIES	--	Equation includes price of beef.
	.90	-.61	semiln	FIES	--	Equation includes price of beef. Evaluated at the means of the data.
	.66	-.45	semiln	FIES	--	Equation includes price of beef. Evaluated at 1981 data.
	2.37	-1.64	ln-ln	FIES	--	Equation includes price of chicken.
	1.62	-1.16	semiln	FIES	--	Equation includes price of chicken. Evaluated at the means of the data.
	1.23	-.88	semiln	FIES	--	Equation includes price of chicken. Evaluated at 1981 data.
1972-81	1.31	n.s	ln-ln	FIES	--	
	1.21	n.s.	semiln	FIES	--	Evaluated at the means of the data.
	1.11	n.s.	semiln	FIES	--	Evaluated at 1981 data.
1972-81	1.09	-.34	ln-ln	FIES	--	Equation includes price of beef.
	1.02	-.33	semiln	FIES	--	Equation includes price of beef. Evaluated at the mean of the data.
	.93	-.31	semiln	FIES	--	Equation includes price of beef. Evaluated at 1981 data.
	2.24	-.96	ln-ln	FIES	--	Equation includes price of chicken.
	2.01	-.88	semiln	FIES	--	Equation includes price of chicken. Evaluated at the means of the data.
	1.86	-.81	semiln	FIES	--	Equation includes price of chicken. Evaluated at 1981 data.
1965	1.17	--	ln-ln	--	FIES	
1970	.71	--	ln-ln	--	FIES	
1975	.38	--	ln-ln	--	FIES	
1979	.43	--	ln-ln	--	FIES	
1981	.44	--	ln-ln	--	FIES	
1981	.44	--	semiln	--	FIES	Evaluated at the mean of weighted data.
1981	.45	--	ln-inv	--	FIES	Evaluated at the mean of weighted data.
	1.43	-1.74	ln-ln	FIES	--	Equation includes price of chicken.

See notes at end of table.

Table 5--Pork: Income and price effects estimated by previous studies--Continued

Author, publication date, and period	Elasticity		Type of equation	Data		Notes
	Income	Own-price		Time series	Cross section	
Rachman, 1974:						
1953-70			2SLS, linear	Whole-sale	--	Income flexibility is 0.20 and own-price flexibility is -0.84.
Sanderson, 1978:						
1965	.61	--	ln-ln	--	FIES	
1973	.75	--	ln-ln	--	FIES	
1963-74	1.04	-1.41	linear	FBS-type	--	
Sawada, 1980:						
1956-70	1.02	-1.81	Rotterdam	FIES	--	Equation includes prices of beef, chicken, and fish.
Uchiyama, 1979:						
1965-78	.42	-.26	ln-ln	FIES	--	Shortrun elasticity.
	.74	-.45	ln-ln	FIES	--	Longrun elasticity.
Williams, 1985:						
1962-82	2.12	-.63	2SLS, ln-ln	FBS-type	--	Equation includes price of fish and a composite price of beef and chicken.
Yuize:						
1966 article:						
1951-60	1.22	-1.17	ln-ln	FIES	--	
	1.17	-1.94	ln-ln	FIES	--	Equation includes price of beef.
1957-62, quarterly	--	-1.78	ln-ln	FIES	--	
1979 article:						
1956-76	.57	-.84	Rotterdam	FBS	--	Equation includes prices of beef, chicken, and fish.

n.s. = Not significant.   -- = Not applicable.
ln-ln : equation ln x = a + b(ln y).   linear : equation x = a + by.
semiln : equation x = a + b(ln y).   ln-inv : equation ln x = a + b(ln/y).
2SLS : two-stage least squares.   3SLS : three-stage least squares.
1/ Ministry of Agriculture, Forestry, and Fisheries.

Estimates of the income elasticity for pork (table 2) from the present study ranged from 0.66 to 1.17, within the range suggested by earlier reports. Several other estimates were not significant. Only two significant estimates, 0.94 from FBS data and 0.66 from FIES data (both for 1967-83), came from equations with a cross price, and for these cases, the cross price was for beef. Otherwise, inclusion of cross prices caused income coefficients to be insignificant. As in the case of beef, FBS-based income elasticities were higher than FIES-based ones, in most cases. FIES estimates using expenditures were higher than those using income in two of the three cases. There were no significant results from the later periods, 1971-83 and 1975-83.

Time Series Evidence on Chicken

Income elasticity estimates for chicken are presented in table 6. In contrast to estimates for beef and chicken, in which log-log and semilog results (at the means) were virtually identical, the time series elasticity estimates of the MAFF for the same periods varied widely between the log-log and semilog forms, although there were no pronounced differences in the goodness of fit as measured by the adjusted R squared.

Income elasticity estimates range from 0.56 (MAFF, 1982, using FIES data for 1963-81 and including the price of beef) to 3.1 (MAFF, 1973, using FIES time series for 1955-64). As with pork, income elasticities for chicken were very high in the fifties, even higher than for beef. Later results include income elasticities for chicken that exceed those of pork and/or beef. Sawada's Rotterdam model found chicken to have the highest elasticity of any meat for 1956-70, and Yuize's Rotterdam model showed a slightly higher elasticity for chicken than for pork. The MAFF estimates from the most recent years (1972-81) were also high for chicken, compared with beef and pork. With some exceptions, the time series estimates for the most recent periods were over 1.

Chicken estimates from the present study (table 3) showed no significant income elasticity using the FBS data and mostly significant results from the FIES data. This is partly because multiple hypotheses using the same subset of variables on the same FBS data were tested. Viewed as single equations and using t-tests, most of the income elasticity estimates would have been over 1 and significantly different from zero. As for beef and pork, FIES estimates of the income elasticity for chicken were higher when using expenditures per person than when using income per person. FIES estimates for 1975-83 were higher than those for 1967-83, which exceeded those for 1967-75, providing some evidence for rising income elasticities. The high levels (over 2 for 1975-83) were consistent with the results of earlier studies. Inclusion of cross prices generally led to insignificant income elasticities.

Cross-section Income Elasticity Estimates for Beef, Pork, and Chicken

Income elasticity estimates from cross section data in tables 4-6 for the three meats in general show a similar pattern. The estimates are usually less than one, and there is a tendency for them to decline until the midseventies, after which they appear to be stable, except for beef.

Of the 14 cross section results reported for beef (table 4), only 4 were over 1 (Sanderson's for 1973 and the MAFF's for 1963, 1965, and 1970). Several studies have looked at cross sectional beef income elasticity results over time. These studies (Yuize, 1979; MAFF, 1973 and 1974, reported in Saxon; Sanderson) found that income elasticities have changed over time, both

Table 6--Chicken: Income and price effects estimated by previous studies

Author, publication date, and period	Elasticity		Type of equation	Data		Notes
	Income	Own-price		Time series	Cross section	
Filippello, 1968:						
1953-64			3SLS, ln-ln	FBS	--	Income flexibility is 0.46 and own-price flexibility is -0.04.
Hayakawa, 1966:						
1957-64	2.81	-1.82	ln-ln	FIES	--	
Kester, 1980:						
1960-75	1.20	-.65	linear	FBS	--	The price variable is the ratio of chicken price to pork price.
Lopez, 1981 (Coyle):						
1965-79	1.10	-1.09	ln-ln	FBS	--	
MAFF 1/:						
1960 report:						
1957	.87	--	ln-ln	--	FIES	
	.99	--	semiln	--	FIES	Evaluated at the means of the data.
1973 and 1974 report (Saxon):						
1955-64	3.10	-1.19	ln-ln	FIES	--	
1960-69	2.21	-2.08	ln-ln	FIES	--	
1963-72	.97	-1.66	ln-ln	FBS	--	
	.81	-2.00	semiln	FIES	--	Evaluated at the means of the data.
1964-73	n.s.	-2.33	ln-ln	FIES	--	
1963	.90	--	ln-ln	--	FIES	
1969	.49	--	ln-ln	--	FIES	
1973	.31	--	ln-ln	--	FIES	
1982 report:						
1963-72	n.s.	n.s.	ln-ln	FIES	--	
	1.27	-1.50	semiln	FIES	--	Evaluated at the means of the data.
	.84	-.99	semiln	FIES	--	Evaluated at 1972 data.
	n.s	-2.30	ln-ln	FIES	--	Equation includes price of beef.
	1.00	-1.55	semiln	FIES	--	Equation includes price of beef. Evaluated at the means of the data.
	.67	-1.03	semiln	FIES	--	Equation includes price of beef. Evaluated at 1972 data.
	2.53	n.s.	ln-ln	FIES	--	Equation includes price of pork.
	1.64	n.s.	semiln	FIES	--	Equation includes price of pork. Evaluated at the means of the data.
	1.08	n.s.	semiln	FIES	--	Equation includes price of pork. Evaluated at 1972 data.
1963-81	2.05	n.s.	ln-ln	FIES	--	
	1.08	-.87	semiln	FIES	--	Evaluated at the means of the data.
	.66	-.55	semiln	FIES	--	Evaluated at 1981 data.
	1.16	-.69	ln-ln	FIES	--	Equation includes price of beef.
	.89	-.98	semiln	FIES	--	Equation includes price of beef. Evaluated at the means of the data.
	.56	-.62	semiln	FIES	--	Equation includes price of beef. Evaluated at 1981 data.
	2.30	n.s.	ln-ln	FIES	--	Equation includes price of pork.

See notes at end of table.

Continued--

Author, publication date, and period	Elasticity		Type of equation	Data		Notes
	Income	Own-price		Time series	Cross section	
MAFF--Continued						
1982:						
1963-81	1.16	-.67	semiln	FIES	--	Equation includes price of pork. Evaluated at the means of the data.
	.74	-.43	semiln	FIES	--	Equation includes price of pork. Evaluated at 1981 data.
1972-81	2.04	-.33	ln-ln	FIES	--	
	1.69	-.41	semiln	FIES	--	Evaluated at the means of the data.
	1.42	-.34	semiln	FIES	--	Evaluated at 1981 data.
1972-81	2.09	-.28	ln-ln	FIES	--	Equation includes price of beef.
	1.66	-.42	semiln	FIES	--	Equation includes price of beef. Evaluated at the mean of the data.
	1.40	-.35	semiln	FIES	--	Equation includes price of beef. Evaluated at 1981 data.
	2.21	n.s.	ln-ln	FIES	--	Equation includes price of pork.
	1.84	n.s.	semiln	FIES	--	Equation includes price of pork. Evaluated at the means of the data.
	1.55	n.s.	semiln	FIES	--	Equation includes price of pork. Evaluated at 1981 data.
1965	.73	--	ln-ln	--	FIES	
1970	.53	--	ln-ln	--	FIES	
1975	.33	--	ln-ln	--	FIES	
1979	.33	--	ln-ln	--	FIES	
1981	.32	--	ln-ln	--	FIES	
1981	.33	--	semiln	--	FIES	Evaluated at the mean of weighted data.
1981	.32	--	ln-inv	--	FIES	Evaluated at the mean of weighted data.
Rachman, 1974:						
1953-70			2SLS, linear	Whole-sale	--	Income flexibility is 0.83 and own-price flexibility is -0.91.
Sanderson, 1978:						
1965	.53	--	linear	--	FIES	
1973	n.s.	--	linear	--	FIES	
1963-74	.97	-2.17	ln-ln	FBS-type	--	
Sawada, 1980:						
1956-70	1.64	-2.18	Rotterdam	FIES	--	Equation includes prices of beef, pork, and fish.

Table 6--Chicken: Income and price effects estimated by previous studies--Continued

Author, publication date, and period	Elasticity		Type of equation	Data		Notes
	Income	Own-price		Time series	Cross section	
Uchiyama, 1979:						
1965-78	.41	-.41	ln-ln	FIES	--	Shortrun elasticity.
	.66	-.62	ln-ln	FIES	--	Longrun elasticity.
Williams, 1985:						
1962-82	.90	-1.74	2SLS, ln-ln	FBS-type	--	Equation includes price of fish and a composite price of beef and pork.
Yuize:						
1966 article:						
1951-60	1.96	n.s.	ln-ln	FIES	--	
	2.07	-2.60	ln-ln	FIES	--	Equation includes a composite price of beef and pork.
1979 article:						
1956-76	.62	-.94	Rotterdam	FBS	--	Equation includes prices of beef, pork, and fish.

n.s. = Not significant. -- = Not applicable.
ln-ln : equation ln x = a + b(ln y).   linear : equation x = a + by.
semiln : equation x = a + b(ln y).   ln-inv : equation ln x = a + b(ln/y).
2SLS : two-stage least squares.   3SLS : three-stage least squares.
1/ Ministry of Agriculture, Forestry, and Fisheries.

according to time series and cross section results. The changes, however, have not shown a regular downward trend, which is what one would expect in a population whose real income has steadily increased. The MAFF cross sections from 1963 through 1975 did show such a downward trend, although Sanderson's comparison of 1965 and 1973, using the same data, showed an upward shift. The MAFF results for 1979 and 1981 indicated that the earlier downward trend had reversed itself, and cross-section income elasticities of 0.9 were found. For cross-section studies, an elasticity slightly below 1 for the most recent period seems to be supported by the previous studies. However, a cross section of household groups from the 1979 NSFIE data (Statistics Bureau, 1981), done as part of this study (table 7), showed a level of 0.39 for beef, considerably lower than the FIES-based cross-section results.

Cross-section results for pork (table 5) and chicken (table 6) both declined until about 1975. For 1977-81, the pork elasticity has been stable in the MAFF estimates at about 0.4, and the chicken elasticity stable at about 0.3. As with beef, Sanderson's results for 1965 and 1973 for pork contradict the MAFF results. The present study's estimates from the 1979 NSFIE study were 0.18 for pork and 0.10 for chicken (table 7), lower than estimates from the FIES in previous studies. The estimates used the log-log specification.

Estimates of Income Elasticities for Fish

Fish and shellfish are large items in Japanese household budgets (about 4 percent of total living expenditures in 1981), and there are a number of income elasticity estimates for this food group. They are given in table 8. Estimates range from -0.13 (Sasaki and Fukagawa, using FIES data, 1958-80) to 0.96 for the same authors' results for 1960-80. A good way to summarize comparable estimates is to retabulate them by type of data (table 9).

The FBS-based estimates in table 9 lie between 0.2 and 0.5, and the FIES-based estimates are all less than 1. This provides some evidence that the relationship between the consumption of fish and shellfish and income is inelastic. The highest estimates come from data that include more recent periods.

Table 7--Income elasticities estimated from 1979 NSFIE results

Food	Income elasticity		Food	Income elasticity	
Beef	0.39	(.03)	Sausage	0.28	(.05)
Pork	.18	(.02)	Milk	.18	(.03)
Chicken	.10	(.02)	Butter	.61	(.03)
Ground meat	.30	(.09)	Cheese	.44	(.05)
Ham	.33	(.02)	Eggs	0	(.01)

Notes: Data listed in appendix. Standard errors are in parentheses.

Table 8--Fish: Income and price effects estimated by previous studies

Author, publication date, and period	Elasticity		Type of equation	Data		Notes
	Income	Own-price		Time series	Cross section	

Various designations--all fish and shellfish products; fish; not otherwise specified; most fish products:

Author, publication date, and period	Income	Own-price	Type of equation	Time series	Cross section	Notes
Filippello, 1968:						
1953-64	--	--	3SLS, ln-ln	FBS	--	Income flexibility is 0.07 and own-price flexibility is -0.58.
Kester, 1980:						
1960-69	.21	--	semiln	FBS	--	
1960-75	.44	.23	linear	FBS	--	
Lee, 1969:						
1959-62	.65-.69	--	ln-ln	MAFF farm household survey	--	The regression was of quantity on income for pooled data, with the slope allowed to vary by year; no prices were included. The elasticity was .65 for 1959, .67 for 1961, .69 for 1962.
1951-62	.80	n.s.	ln-ln	MAFF	--	The equation included a price index for meat, milk, and eggs.
	.93	n.s.	ln-ln	MAFF	--	The equation included price indexes for meat, milk, and eggs, and for condiments.
Lopez, 1981 (Coyle):						
1960-78	.49	--	ln-ln	FBS	--	
MAFF 1/:						
1982 report:						
1963-72	.68	-.63	ln-ln	FIES	--	
	.68	-.61	semiln	FIES	--	Evaluated at the means of the data.
1963-81	.81	.86	ln-ln	FIES	--	
	.80	-.86	semiln	FIES	--	Evaluated at the means of the data.
1972-81	n.s.	-.49	ln-ln	FIES	--	
	n.s.	-.49	semiln	FIES	--	Evaluated at the means of the data.
Sasaki, 1982:						
1951-60	.23	-.11	LES, A	FIES	--	The equations include Laspeyres price indexes for 23 (sometimes 21) other commodity groups, deflated by the CPI. Elasticity calculated at the means of the data.
1961-70	n.s.	n.s.	LES, A	FIES	--	
1963-77	n.s.	n.s.	LES, A	FIES	--	
1958-77	n.s.	n.s.	LES, A	FIES	--	
Sasaki and Fukagawa, 1984:						
1951-61	.18	-.06	LES, A	FIES	--	see notes for Sasaki, 1982, above.
1958-80	-.13	.06	LES, A	FIES	--	
1960-80	.96	-.41	LES, A	FIES	--	

See notes at end of table.

Table 8--Fish: Income and price effects estimated by previous studies--Continued

Author, publication date, and period	Income	Own-price	Type of equation	Time series	Cross section	Notes
		Elasticity		Data		

Various designations--all fish and shellfish products; fish; not otherwise specified; most fish products--continued:

Author, publication date, and period	Income	Own-price	Type of equation	Time series	Cross section	Notes
Sasaki and Saegusa, 1974:						
1958-68	.11	-.06	LES, A	FIES	--	The equation includes nine other price indexes: 1 for nonfoods and 8 for food groups. Elasticities calculated at the means of the data.
Sawada, 1980:						
1956-70	.24	-.27	Rotterdam	FIES	--	The estimation includes prices of beef, pork, and chicken.
Yuize, 1966:						
1957-62	--	-.97	ln-ln	FIES	--	Quarterly data. An income elasticity of .44 was subtracted from the dependent variable before regression.
1951-60	.26	-.75	ln-ln	FIES	--	
	.48	-1.07	ln-ln	FIES	--	The equation includes price of beef.
Yuize, 1979:						
1956-76	.33	-.22	Rotterdam	FBS	--	The estimation includes prices of beef, pork, and chicken.

Fresh fish and shellfish:

Author, publication date, and period	Income	Own-price	Type of equation	Time series	Cross section	Notes
MAFF, 1973 and 1974 report (Saxon):						
1963-72	n.s.	n.s.	ln-ln	FBS	--	
1982 report:						
1963-72	n.s.	-.33	ln-ln	FIES		
	n.s.	-.33	semiln	FIES		Evaluated at the means of the data.
	.59	-.68	ln-ln	FIES		Equation includes price index for fresh meat.
	n.s.	n.s.	ln-ln	FIES		Equation includes price index for salted and dried fish.
1963-81	n.s.	n.s.	ln-ln	FIES		
	n.s.	n.s.	semiln	FIES		Evaluated at the means of the data.
	n.s.	n.s.	ln-ln	FIES		Equation includes price index for fresh meat.
	n.s.	n.s.	ln-ln	FIES		Equation includes price index for salted and dried fish.
1972-81	n.s.	n.s.	ln-ln	FIES		
	n.s.	n.s.	semiln	FIES		Evaluated at the means of the data.
	n.s.	n.s.	ln-ln	FIES		Equation includes price index for fresh meat.
	n.s.	n.s.	ln-ln	FIES		Equation includes price index for salted and dried fish.

Continued--

See notes at end of table.

Table 8--Fish: Income and price effects estimated by previous studies--Continued

Author, publication date, and period	Elasticity		Type of equation	Data		Notes
	Income	Own-price		Time series	Cross section	

Author, publication date, and period	Income	Own-price	Type of equation	Time series	Cross section	Notes
Fresh fish:						
Crutchfield, 1980: 1955-79	n.s.	-.61	ln-ln	whole-sale		Equation deals only with fresh pollack; price flexibility is -.61, income flexibility is n.s.
Hayakawa, 1966: 1957-64	-.15		ln-ln	FIES		
1956-64	-.06	-.33	ln-ln	FIES		The price variable is the price index of fish divided by that for meat.
MAFF, 1982:						
1963-72	n.s.	-.31	ln-ln	FIES		
	n.s.	n.s.	semiln	FIES		Evaluated at the means of the data.
1963-81	n.s.	n.s.	ln-ln	FIES		
	n.s	n.s.	semiln	FIES		Evaluated at the means of the data.
1972-81	n.s.	.20	ln-ln	FIES		
	n.s.	n.s.	semiln	FIES		Evaluated at the means of the data.
1965	-.04	--	ln-ln		FIES	
1973	n.s.	--	ln-ln		FIES	
1975	n.s.	--	ln-ln		FIES	
1979	n.s.	--	ln-ln		FIES	
1981	n.s.	--	ln-ln		FIES	
	n.s.	--	semiln		FIES	Evaluated at the means of the data.
	n.s	--	ln-inv		FIES	Evaluated at the means of the data.
Salted and dried fish:						
MAFF, 1973, 1974 (Saxon):						
1955-64	.45	-1.25	ln-ln	FIES		
1960-69	2.95	-3.21	ln-ln	FIES		
1964-73	1.33	-.88	ln-ln	FIES		
1963	.32	--	ln-ln		FIES	
1969	.19	--	ln-ln		FIES	
1973	.28	--	ln-ln		FIES	
MAFF, 1982:						
1963-72	1.39	-1.05	ln-ln	FIES		
	1.41	-1.08	semiln	FIES		Evaluated at the means of the data.
	1.39	-1.01	ln-ln	FIES		Equation includes price index for fresh meat.
	1.50	-1.08	ln-ln	FIES		Equation includes price index for fresh fish and shellfish.
1963-81	1.46	-1.26	ln-ln	FIES		
	1.56	-1.42	semiln	FIES		Evaluated at the means of the data.
	1.37	-1.19	ln-ln	FIES		Equation includes price index for fresh meat.
	1.87	-1.12	ln-ln	FIES		Equation includes price index for fresh fish and shellfish.

Continued--

See notes at end of table.

Table 8--Fish: Income and price effects estimated by previous studies--Continued

Author, publication date, and period	Elasticity		Type of equation	Data		Notes
	Income	Own-price		Time series	Cross section	
Salted and dried fish--continued:						
1972-81	1.68	-1.71	ln-ln	FIES		
	1.75	-1.72	semiln	FIES		Evaluated at the means of the data.
	n.s.	-1.90	ln-ln	FIES		Equation includes price index for fresh meat.
	3.29	-.95	ln-ln	FIES		Equation includes price index for fresh fish and shellfish.
1965	.27	--	ln-ln		FIES	
1970	n.s.	--	ln-ln		FIES	
1975	.31	--	ln-ln		FIES	
1979	.29	--	ln-ln		FIES	
1981	n.s.	--	ln-ln		FIES	
	n.s.	--	semiln		FIES	
	n.s.	--	ln-inv		FIES	

n.s. = Not significant.   -- = Not applicable.
ln-ln : equation ln x = a + b(ln y).   linear : equation x = a + by.
semiln : equation x = a + b(ln y).   ln-inv : equation ln x = a + b(ln/y).
3SLS = three-stage least squares.   LES, A = Linear expenditure system, approximated.
1/ Ministry of Agriculture, Forestry, and Fisheries.

The fish category is so diverse that consistent results can hardly be expected. The Japanese consumed 35.7 kilograms (kg) per person in 1984 of fish and shellfish. Of that amount, 15 kg were fresh, chilled, or frozen, 19.1 kg salted, dried, or smoked, and 1.6 kg were in airtight containers.

Table 8 gives some results of attempts to estimate the income elasticities for the fresh and the salted and dried categories of fish and shellfish. The results for fresh fish or for fresh fish and shellfish have rarely been significantly different from zero. Income elasticity estimates for salted and dried fish are high, and they seem to rise during more recent periods.

The lack of nonzero income elasticity estimates for fresh fish and shellfish is somewhat surprising because they are often assumed to be income elastic products. Table 10 shows the results of regressions on cross sections of income groups from the FIES for various years and for individual fresh fish and shellfish types. The estimates range from negative values to over 1. If fish with such widely differing relationships to income are lumped together in the category fresh fish and shellfish, it is not surprising that the results are not significantly different from zero, as in table 8.

Own-Price Elasticities

Own-price elasticity estimates for beef from earlier studies are given in table 4. The range of estimates is from -0.24 (Yuize, 1966, for 1957-62 FIES quarterly data) to -2.77 (Yuize, 1979, for 1964-76 FIES data). Most estimates are between -1 and -2. The estimates showing the highest price elasticity tend to come from the earliest data sets, and several estimates on recent data by the MAFF are close to 1. Thus, these estimates show that beef is a relatively price elastic food, although the price responsiveness may be decreasing. Regressions on FBS and FIES data done for beef in the present study (see table 1) produced significant elasticity estimates ranging from -0.62 to -1.82, as well as a large number of estimates that did not differ

Table 9 -- Fish and shellfish: Estimates of income elasticities by data source and period

FBS		FIES	
Estimate	Period	Estimate	Period
0.21	1960-69	-0.13	1958-80
.33	1956-76	.11	1958-68
.44	1960-75	.18	1951-61
.49	1960-78	.23	1951-60
		.24	1956-70
		.26	1951-60
		.48	1951-60
		.67	1963-72
		.68	1963-72
		.80	1963-81
		.81	1963-81
		.96	1960-80

Table 10--Fresh fish and shellfish: Expenditure elasticities using cross sections of income groups from the Family Income and Expenditure Survey, Japan

Fish type	1957 1/	1963 2/	1965 2/	1970 2/	1973 2/	1975 2/	1979 3/	1981 3/	1984 4/
Bonito	n.s.	.21	-.09	-.16	.23	.24	.28	.32	
Clams, shortnecked									-.19
Cod									-1.03
Corbicula									-.44
Crab								1.01	.79
Cuttle fish									-.67
Flat fish			.76		.96	.58	1.00	1.04	n.s.
Flounder	1.55								-1.00
Herring	1.02								
Horse mackerel		-.41	-.38	-.22	-.20	-.02	.24	.35	-.69
Jack mackerel	-.16								
Mackerel		-.41	-.55	-.73	-.91	-.32	-.35	-.43	-1.93
Octopus	.70								-.80
Oyster									.37
Salmon	1.20	.97	1.02	.66	.59	.37	.65	.42	n.s.
Sardines	-.38								-1.04
Saury		-.39	-.15	.29	-.03	-.05	-.02	-.02	-1.36
Sea bream	.97	.65	.92	.19	.09	.32	.70	.32	n.s.
Shrimp/prawn	.55								
Shrimp and lobster								.91	.31
Shrimps, lobsters, and crabs			1.09		.79	.56	.75		
Tuna	.82	1.27	1.32	.65	.64	.35	.42	.48	n.s.
Tuna, for eating raw 5/	1.02								
Yellowtail	.73								n.s.
Other fresh fish	.51								-.98
Other shellfish	.56								n.s.
Unclassifiable									n.s.

Notes: n.s. = Not significant. From equations of the form ln x = a + b(ln y), except as noted.
1/ Results are based on 19 income groups, and come from the 1960 MAFF study.
2/ Results for 1963-75 are based on 14 income groups, and come from the 1982 MAFF study.
3/ Results for 1979-81 are based on 16 income groups, and come from the 1982 MAFF study.
4/ Results are based on five income groups and were estimated as part of the present study. Data are from the FIES--Statistics Bureau, 1985, pp. 186-97.
5/ From an equation of the form x = a + b(ln y).

significantly from zero. None of the FBS estimates is significant, and in regressions with either type of data, own-price estimates are never significant when other prices are included. Obviously, there is a major multicollinearity problem in the estimation of own-price elasticities for beef.

Pork price elasticities (table 5) range from about -0.3 (MAFF, using FIES data, 1972-81) to about -2.3 (MAFF, with 1963-72 data). The estimates based on more recent data rarely show an elasticity greater than 1 in absolute value. Pork appears to have become price inelastic since the sixties, with current estimates in the range -0.4 to -1.

Pork price elasticities from regressions of the present study (table 2) range from -0.22 to -1.26 for Japan, with only one estimate greater than 1 in absolute value. Compared with beef, significant own-price elasticities for pork were easier to obtain. The three significant results from FBS data (-0.86 to -1.26) were generally more elastic than the eight significant FIES results (-0.22 to -1.10); why that should be is unclear. Comparing equation 4 in table 2 with equation 1, the inclusion of the cross price of beef raised the own-price elasticity of pork (in absolute value), and the same situation is evident when one compares equations 7 and 13-16. This suggests that excluding the price of beef (or perhaps other cross prices) biases the own-price elasticity downward to a lower absolute level. I saw no pattern of change over time in the own-price elasticity estimates done for the update.

Own-price elasticity estimates for chicken from earlier studies (table 6) ranged from about -0.3 (MAFF, using FIES data from 1972-81) to -2.3 (MAFF, 1964-73 data). This is the same range as for pork, and as with pork, the elasticities tend to fall over time. Elasticities for recent data were in the -0.4 to -1 range, with few exceptions.

Estimates of the chicken own-price elasticity from FIES data in table 3 (estimates from FBS data were not significant) go from -0.6 to -1.8, a wide range. Only estimates from the early period, 1967-75, were 1 or more in absolute value; estimates from more recent periods were 1 or less in absolute value or not significant. Two own-price estimates were significant when a cross price was introduced, but the regressions I undertook also provide evidence of serious multicollinearity problems among prices and income.

Own-price elasticity estimates for fish (table 8) must be viewed with some skepticism, because it is hard to get matched quantity and price information for such a vast and diverse group. Data from the FBS are preferable, because the quantity data have been carefully put together so as to actually estimate quantities eaten by humans. The marine items in the FIES are listed according to their retail form and weight, not according to their actual table weight. When the FIES fish quantities are summed into a total weight some spurious weight is added in, varying by year with catches.

A further problem is that published reports often cite a price index and an aggregate quantity without giving sufficient information. For example, price indices for all fish and shellfish, fresh fish and shellfish, and for salted and dried fish are commonly available. Quantity aggregates for each category can be constructed as well. It is inappropriate to do regressions using one of the price indices and a different quantity aggregate, but some researchers may have done that nonetheless. When no information is given about the price index or the category of fish used, regression results are less useful.

The results in table 8 for all fish and shellfish, for fresh fish and shellfish, and for fresh fish show price elasticities between 0 and -1. For salted and dried fish and shellfish, elasticity estimates are generally elastic, between -1 and -2.

Cross-Price Elasticities

Estimates of cross price elasticities at a commodity level of detail (that is, beef, pork, chicken, rather than meats) are uncommon. Coyle lists two studies, both done for ERS (Filippello, 1970, and Kester). Several other studies' results are reported in appendix tables 1-3. Tables 11-17 present subsets of the results. The simultaneous equation models of Filippello (1968) and Rachman were discussed earlier. Their results are in terms either of cross flexibilities (not elasticities) or of correlations between prices. Therefore, these results are of limited use in trying to narrow the range of possible cross elasticities. Rachman's equations, in particular, suffer from the effects of finding variables that are statistically significant, rather than reporting estimates of equations that contain variables whose relation to the dependent variable better reflect the logic of market forces.

Filippello (1970) reported on a set of projections to 1980 of demand and supply of agricultural commodities. He used OLS, 2SLS, 3SLS, and factor analysis with linear equations to estimate demand and supply elasticities from historical data, but emphasized his projection methods in the report, omitting information about the regression results. Because of a lack of standard errors for the estimated parameters, lack of knowledge of the methods used for obtaining them, and uncertainty about which period his historical data covered, Filippello's elasticity estimates were not reproduced here. Liu (1985) presented a model designed to forecast future Japanese supply, demand, and trade of grain, oilseeds, and livestock. As part of the model, she used equations that forecast demand of beef, pork, poultry and 16 other products. She estimated some of the parameters from historical data and selected others from published studies. Like Filippello, her goal was to present a relatively comprehensive model for forecasting, and she did not publish details about the elasticities that she used.

Kester's single-equation estimates are of interest because she reports numerous cross-price elasticities. The data presented in her paper (which was not ready for publication) do not appear to be the data used for the regression results reported.

It is in the search for cross elasticities that the strength of the demand systems approach is evident. Although there are many estimates of income and own-price elasticities from single equations, cross price elasticities in tables 11-17 rely heavily on the results of two Rotterdam models. Yuize presented only a summary of his results in his 1979 paper, with no information about his methods and no standard errors for any part of his estimation procedure. This makes evaluation of his model difficult. Sawada provided a lot of detail on his results, which seem to be quite useful.

We can make some tentative conclusions from these tables. One must realize, however, that all of the studies had to make serious compromises that question the validity of their results. Note, too, that the elasticities are gross substitution elasticities, combining true substitution (or complementarity) with changes in consumption caused by income shifts that resulted from price changes.

Beef

Table 11 presents results of regression equations in which only the prices of beef and pork, and an income measure, were used as variables. Only two studies reported significant results for both beef and pork prices, both for early periods. Evidently, the prices of these meats and income are highly collinear, and nonsignificant results may be attributable to multicollinear and/or omitted data rather than to lack of price response or response of an unexpected kind.

Table 12 includes results with more cross prices--for pork, chicken, and fish. All the equations used three cross prices in addition to beef prices and income variables, except for Williams' equations, which combined the pork and chicken prices. The two Rotterdam estimates of the pork elasticity, 0.5 and 0.6, are close to each other. Results for the chicken price elasticity were not significant, or zero, in most cases. Williams' allocation of the coefficient of the mixed price to pork and chicken is arbitrary; however, some substitution effect seems to be reflected in the coefficient of the combined variable of 0.37 that he reported. Liu used cross price elasticities of pork (0.15) and poultry (0.3) in her beef demand equation. The results for the fish price index vary widely. High multicollinearity probably caused the results in the update and in Narita to be poor, and the high fish price

Table 11--Beef: Estimates from equations with pork as the only cross price for beef in Japan

Author, publication date, and period	Elasticities			Data source and type of equation
	Own price (beef)	Cross price (pork)	Income	
Kester, 1980				
1960-70	-.99	1.02	.63	FBS, linear
MAFF, 1982				
1963-72	-1.92	n.s.	1.19	FIES, ln-ln
	-1.86	n.s.	1.15	FIES, semiln
1963-81	-1.70	n.s.	1.37	FIES, ln-ln
	-1.56	n.s.	1.25	FIES, semiln
1972-81	-1.08	n.s.	1.85	FIES, ln-ln
	-1.03	n.s.	1.83	FIES, semiln
Yuize, 1962				
1951-60	-.92	.63	1.05	FIES ln-ln
Dyck:				
1967-83	n.s.	-.60	1.73	FBS, ln-ln
	n.s.	-.53	.91	FIES, ln-ln

n.s. = Not significant. Note: The results came from equations of the form X = f(Y, Pbeef, Ppork), where X = consumption of beef, Y = income, Pbeef = price of beef, and Ppork = price of pork. Elasticities calculated at the means of data in the semiln regressions.

elasticities estimated by the present study should be discounted. It is unclear whether Yuize, Sawada, and Williams used the same fish price index. Except for some evidence that pork is a substitute for beef, in table 12, both tables 11 and 12 are unsatisfactory, and show that, econometrically, we can demonstrate very little about the cross-price relationships of beef.

Pork

Three tables give results of regression equations using the price of beef (table 13), the prices of beef and chicken (table 14), and the prices of beef, chicken, and fish (table 15) as cross prices. In general, the results are better than those for the cross prices of beef. The cross-price elasticity of pork consumption with respect to the beef price is significant in all the equations from both the current and earlier studies. It is also quite high, ranging from 0.4 to 1.5 (table 13). In the MAFF results, the elasticity estimated from the log-log equations always exceeded that from the semilog equations, evaluated at the means, comparing equations from the same time periods.

Estimates of the cross price elasticity of chicken are between 0.2 and 1.6 (table 14). The MAFF (1982) found high elasticities, using chicken as the

Table 12--Beef: Estimates from equations with pork, chicken, and fish as cross prices, Japan

Author, publication date, and period	Own price (beef)	Elasticities				Income	Data source
		Cross price					
		Pork	Chicken	Mixed	Fish		
Narita, 1986: 1963-83	-1.00	n.s.	n.s.		n.s.	n.s.	FIES
Sawada, 1980: 1956-70	-1.38	.51	1/0.14		.05	1.09	FIES
Yuize, 1979: 1956-76	-1.10	.60	0		.16	1.00	FBS
Williams, 1985: 1962-82	-1.43	(.21)	(.16)	2/.37	.55	1.15	FBS-type
Dyck: 1967-83	n.s. n.s.	n.s. n.s.	n.s. -.58		1.15 .88	n.s. n.s.	FBS FIES

n.s. = Not significant. Note: The results above came from equations of the form X = f(Y, Pbeef, Pother), where X = consumption of beef, Y = income, Pbeef = price of beef, and Pother = prices of substitutes. 1/ Erroneously reported as .41 in one table in Sawada. 2/ Williams' regression estimate was for a mixed pork and chicken price; part of the elasticity was later assigned to each of the meats.

only cross price. Four other studies estimated the chicken price elasticity between 0.2 and 0.3. Three of these four have unanswered questions about either the data used or the confidence interval of the elasticity. Liu used elasticity estimates of 0.12 for poultry and 0.3 for beef. Thus, some evidence seems to point to the chicken price as being significant and positive in determining pork consumption.

The results of the present study are not as clear as those of earlier studies. While beef emerges as an important substitute for pork, the chicken price is never significant. The fresh fish and shellfish price index causes poor results for other coefficients.

Chicken

Table 16 presents estimates from equations handling only beef and pork cross prices, and table 17 presents estimates in which the fish price index is also considered. Few significant cross-price estimates appear. Both Yuize (1966) and Williams used a composite cross price. A single result from the present study showed significant own-price, cross-price, and income elasticities for 1967-83, using beef as a substitute. The systems' estimates by Yuize (1979) and Sawada produced results for pork and fish cross-price elasticities that

Table 13--Pork: Estimates from equations with beef as the only cross price, Japan

Author, publication date, and period	Elasticities			Data source and functional form
	Own price (pork)	Cross price (beef)	Income	
MAFF, 1982:				
1963-72	-1.24	1.06	0.95	FIES, ln-ln
	-1.09	.60	1.11	FIES, semiln
1963-81	-.64	1.18	.82	FIES, ln-ln
	-.61	.52	.90	FIES, semiln
1972-81	-.34	.46	1.09	FIES, ln-ln
	-.33	.40	1.02	FIES, semiln
Uchiyama, 1979:				
1965-78	1/-.45	1/.72	1/.74	FIES, ln-ln
Yuize, 1966:				
1951-60	-1.94	1.54	1.17	FIES, ln-ln
Dyck:				
1967-83	-1.26	1.04	.94	FBS, ln-ln
	-.72	.97	.66	FIES, ln-ln

Note: The results came from equations of the form X = f(Y, Ppork, Pbeef), where X = consumption of pork, Y = income, Ppork = price of pork, and Pbeef = price of beef.
1/ Longrun elasticities.

Table 14--Pork: Estimates from equations with chicken as a cross price, Japan

| | Elasticities | | | | Data source |
| | Own price | Cross price | | Income | and type |
	(pork)	Beef	Chicken	Mixed		of equation
Kester, 1980:						
1960-75	-0.77	0.63	0.28		0.85	FBS, linear
MAFF, 1982:						
1963-72	-2.28		n.s.		2.81	FIES, ln-ln
	-1.74		n.s.		2.35	FIES, semiln
1963-81	-1.64		1.57		2.37	FIES, ln-ln
	-1.16		.82		1.62	FIES, semiln
1972-81	-.96		.94		2.24	FIES, ln-ln
	-.88		.82		2.01	FIES, semiln
Williams, 1985						
1962-82	-1.43	(.58)	(.25)	1/.83	1.65	FBS-type, ln-ln, 2SLS
Dyck:						
1967-83	-.54	1.10	n.s.		.52	FIES, ln-ln

n.s. = Not significant.   2SLS = Two-stage least squares.
Note: The results came from equations of the form X = f(Y, Ppork, Pother), where X = consumption of pork, Y = income, Ppork = price of pork, and Pother = prices of substitutes. Elasticities for the semiln equations calculated at the means of the data. 1/Williams found .83 for a composite of beef and chicken prices, and divided .83 into beef and chicken elasticities

Table 15--Pork: Estimates from equations with beef, chicken, and fish as cross prices, Japan

| Author, | | Elasticities | | | | Data source |
| publication date, | Own price | Cross price | | | Income | and type |
and period	(pork)	Beef	Chicken	Fish		of equation
Sawada, 1980:						
1956-70	-1.81	0.61	0.23	0.35	1.02	FIES, Rotterdam
Yuize, 1979:						
1956-76	-.84	.43	.20	.01	.57	FBS, Rotterdam
Dyck:						
1971-83	n.s.	n.s.	n.s.	1.26	1.16	FBS, ln-ln
1967-83	-.56	.94	n.s.	.94	-.39	FIES, ln-ln

Note: The results above came from equations of the form X = f(Y, Ppork, Pother), where X = consumption of pork, Y = income, Ppork = price of pork, and Pother = price of substitutes

are compatible with each other, but the estimates of the beef cross-price elasticity are sharply different, as are the own-price and income elasticities. Liu used 0.07 for beef and 0.22 for pork in her projection equations. Additional estimates, by the 1982 MAFF study, used the price of pork as the only cross price. The results (app. table 2) were not significant. Tables 16 and 17 do not provide much information on the location and extent of substitution effects for chicken.

Table 16—Chicken: Estimates from equations with beef or pork as cross prices, Japan

| Author, publication date, and period | Own price (chicken) | Elasticities | | | Income | Data source and type of equation |
| | | Cross price | | | | |
		Beef	Pork	Mixed		
MAFF, 1982:						
1963-72	-2.30	1.09			n.s.	FIES, ln-ln
	-1.55	.38			1.00	FIES, semiln
	n.s.		-1.17		2.53	FIES, ln-ln
	n.s.		n.s.		1.64	FIES, semiln
1963-81	-.69	.93			1.16	FIES, ln-ln
	-.98	n.s.			.89	FIES, semiln
	n.s.		-.67		2.30	FIES, ln-ln
	-.67		n.s.		1.16	FIES, semiln
1972-81	-.28	n.s.			2.09	FIES, ln-ln
	-.42	n.s.			1.66	FIES, semiln
	n.s.		-.30		2.21	FIES, ln-ln
	n.s.		n.s.		1.84	FIES, semiln
Williams, 1985:						
1962-82	-1.74	(.36)	(.20)	1/.56	.90	FBS-type, ln-ln, 2SLS
Yuize, 1966:						
1951-60	-2.60			2.04	2.07	FIES, ln-ln
Dyck:						
1967-83	-.96	.75			.71	FIES, ln-ln
	-.52		n.s.		1.13	FIES, ln-ln
	-.80	.72	n.s.		.77	FIES, ln-ln
1971-83	-1.01	n.s.			1.24	FBS, ln-ln
	-.73		n.s.		1.08	FBS, ln-ln
	-.68	n.s.	n.s.		n.s.	FBS, ln-ln

n.s. = Not significant. Note: The results came from equations of the form X = f(Y, Pchicken, Pother), where X = consumption of chicken, Y = income, and Pother = prices of substitutes.

1/Williams estimated .56 from a composite price of beef and pork, and then divided .56 between beef and pork.

Table 17—Chicken: Estimates from equations with beef, pork, and fish as cross prices, Japan

Author, publication date, and period	Own price (chicken)	Elasticities			Income	Data source and type of equation
		Cross price				
		Beef	Pork	Fish		
Sawada, 1980: 1956-70	-2.18	.40	.53	.26	1.64	FIES, Rotterdam
Yuize, 1979: 1956-76	-.94	0	.35	.37	.62	FBS, Rotterdam
Dyck: 1971-83	n.s.	n.s.	n.s.	1.28	1.37	FBS, ln-ln

n.s. = Not significant. Note: The results above came from equations of the form X = f(Y, Pchicken, Pother), where X = consumption of chicken, Y = income, Pchicken = price of chicken, and Pother = prices of substitutes.

Fish

Fish cross-price elasticities with respect to the prices of individual meats are small (table 18). The largest ones (0.24 for beef and 0.16 for chicken) were found by Kester and are not well documented. Filippello (1968) found some evidence that fish and chicken are complements, but the cross flexibility he calculated was small. His 1970 report regarded meats as substitutes. Price elasticity estimates at 1965 levels were 0.33 for beef, 0.21 for pork, and 0.15 for chicken.

Because fish is an aggregate category containing many diverse types, a logical variable to use is a price index for the aggregate category, meats. Hayakawa found a negative cross-price elasticity for 1956-64, while Yuize (1962 and 1966) found positive effects by meat price changes (table 19). Yuize found a significant substitution of meat for fish in the fifties, with data from nonfarm households. Lee, however, found no evidence of substitution in farm households during the same period. Yamashita, Sasaki and Saegusa, and Sasaki and Fukagawa also failed to find a relationship. The relative lack of success in finding an effect of meat price indices on fish consumption may be tied to the double problems of obtaining a cohesive fish quantity aggregate and a meat price index.

Several studies have used fish price indices in estimating aggregate meat consumption, but, as table 20 shows, the results often do not show significant effects. The negative cross-price elasticities of Sasaki and Saegusa's and Sasaki and Fukagawa's approximations of the LES are consequences of the LES model rather than of the data. All goods in an LES are usually gross complements. In any event, the meat-fish cross elasticities they estimate are almost zero. Only Yamashita, using a simple linear equation and a rather long time series, found a notable effect of fish prices on meat. I did not collect the data from the sources she cited in order to calculate the elasticity.

Table 18—Fish: Substitution relationships estimated by previous studies, Japan

Author, publication date, and period	Fish variable	Beef variable	Type of equation	Elasticity (Flexibility)
Filippello, 1968: 1953-64	wholesale price index/CPI	Q, FBS	3SLS, ln-ln	1/(0.32)
Kester, 1980: 1960-69	Q, FBS	P, retail/CPI	semiln	2/.24
Sawada, 1980: 1956-70	Q, FIES	P, FIES	Rotterdam	3/.01
Yuize, 1979: 1956-76	Q, FBS	P, retail	Rotterdam	4/.04

Author, publication date, and period	Fish variable	Pork variable	Type of equation	Elasticity
Sawada, 1980: 1956-70	Q, FIES	P, FIES	Rotterdam	3/0.08
Yuize, 1979: 1956-76	Q, FBS	P, retail	Rotterdam	4/0.

Author, publication date, and period	Fish variable	Chicken variable	Type of equation	Elasticity (Flexibility)
Filippello, 1968: 1953-64	Wholesale price index/CPI	Q, FBS	3SLS, ln-ln	1/(-0.08)
Kester, 1980: 1960-69	Q, FBS	P, retail/CPI	semiln	2/.16
Sawada, 1980: 1956-70	Q, FIES	P, FIES	Rotterdam	3/.03
Yuize, 1979: 1956-76	Q, FBS	P, retail	Rotterdam	4/0.

Notes: Q = Quantity. P = Price. ln-ln = equation of the form ln x = a + b(ln y). semiln = equation of the form x = a + b(ln y). 3SLS = three-stage least squares.
1/ The equation includes beef and chicken quantities.
2/ The equation includes beef and chicken prices.
3/ The fish quantity includes fresh fish, salted and dried fish, and whale meat, and the equation includes beef, pork, and chicken prices. Elasticities were calculated at the means of the data.
4/ The equation includes beef, pork, and chicken prices. Neither standard errors not details on the significance test were reported. Elasticities were calculated at 1970 data.

Table 19--Substitution relationships between fish and meat estimated by previous studies, Japan

Author, publication date, and period	Fish variable	Meat price index	Type of equation	Elasticity
Hayakawa, 1966:				
1956-64	Q fresh fish, FIES	fish/meat	ln-ln	1/-0.33
	Q low quality fresh fish, FIES	fish/meat	ln-ln	2/-.99
	Q high and medium quality fresh fish, FIES	fish/meat	ln-ln	3/.42
Lee, 1969:				
1951-62	Q fish, farm survey	meat, milk, and eggs	ln-ln	n.s.
MAFF, 1982:				
1963-72	Q fresh fish, FIES	fresh meat index/CPI	ln-ln	-.70
	Q salted and dried fish, FIES	fresh meat index/CPI	ln-ln	n.s.
1963-81	Q fresh fish, FIES	fresh meat index/CPI	ln-ln	n.s.
	Q salted and dried fish, FIES	fresh meat index/CPI	ln-ln	n.s.
1972-81	Q fresh fish, FIES	fresh meat index/CPI	ln-ln	n.s.
	Q salted and dried fish, FIES	fresh meat index/CPI	ln-ln	n.s.
Sasaki, 1982:				
1951-60	Q fish, FIES	Laspeyres index/CPI	LES, A	4/0.
1961-70	Q fish, FIES	Laspeyres index/CPI	LES, A	4/0.
Sasaki and Fukagawa, 1984:				
1951-61	Q, FIES	Laspeyres index/CPI	LES, A	4/0.
Sasaki and Saegusa, 1974:				
1958-68	Q, FIES	P, retail/CPI	LES, A	5/0.
Yamashita, 1973:				
1951-69	Q, FIES	P, FIES, undeflated	linear	n.s.
Yuize, 1962:				
1951-60	Q, FIES	P, retail, undeflated	linear	6/
Yuize, 1966:				
1951-60	Q, FIES	P, FIES/CPI	ln-ln	.52

Notes: Q = Quantity. P = Price. n.s. = Not significant. ln-ln = equation of the form ln x = a + b(ln y). linear = equation of the form x = a + by. LES, A = linear expenditure system, approximated.

1/ Laspeyres price index for fresh fish, divided by CPI subindex for all meats and meat products

2/ Laspeyres price index for low quality fresh fish, divided by CPI subindex for all meats and meat products.

3/ Laspeyres price index for high and medium quality fresh fish, divided by CPI subindex for all meats and meat products.

4/ Equation includes 22 other group price indexes.

5/ Equation includes price indexes for 8 other food groups and a nonfood group.

6/ Positive coefficient, elasticity not calculated.

Table 20--Substitution relationships between meat and fish estimated by previous studies, Japan

Author, publication date, and period	Meat variable	Fish price index	Type of equation	Elasticity
Lee, 1969:				
1951-62	Q meat, milk and eggs, farm survey	not clear	ln-ln	n.s.
MAFF, 1982:				
1963-72	Q fresh meat, FIES	index for fresh fish/CPI	ln-ln	n.s.
	Q fresh meat, FIES	index for salted and dried fish/CPI	ln-ln	n.s.
1963-81	Q fresh meat, FIES	index for fresh fish/CPI	ln-ln	n.s.
	Q fresh meat, FIES	index for salted and dried fish/CPI	ln-ln	n.s.
1972-81	Q fresh meat, FIES	index for fresh fish/CPI	ln-ln	n.s.
	Q fresh meat, FIES	index for salted and dried fish/CPI	ln-ln	n.s.
Sasaki, 1982:				
1951-60	Q, FIES	Laspeyres index/CPI	LES, A	1/-.059
1961-70	Q, FIES	Laspeyres index/CPI	LES, A	1/-.046
Sasaki and Fukagawa, 1984:				
1951-61	Q, FIES	Laspeyres index/CPI	LES, A	1/-.06
Sasaki and Saegusa, 1974:				
1958-68	Q, FIES	retail/CPI	LES, A	2/-.06
Yamashita, 1973:				
1951-69	Q, FIES	FIES, undeflated	linear	3/
Yuize, 1962:				
1951-60	Q, FIES	retail, undeflated	linear	n.s.
Yuize, 1966:				
1951-60	Q, FIES	FIES/CPI	ln-ln	n.s.

Notes: Q = Quantity. P = Price. n.s. = Not significant.
ln-ln = equation of the form ln x = a + b(ln y).
linear = equation of the form x = a + by. LES, A = linear expenditure system, approximated.
1/ Equation includes 22 other group price indexes.
2/ Equation includes price indexes for 8 other food groups and a nonfood group.
3/ Positive coefficient, elasticity not calculated.

The lack of a stronger effect of a fish price index on meat consumption is interesting, because, even if fish and meat were not close substitutes, the expenditures on fish account for a large share of food expenditures, and a change in a fish price index would be expected to have a noticeable income effect on the consumption of other foods. Thus, the studies I examined do not provide convincing evidence either for the substitution of meat for fish or the substitution of fish for meat.

In an attempt to reduce the aggregation problems, Hayakawa divided fish into low and medium-high categories. He regressed a fish quantity measure on income and the ratio of fish to meat prices. The price variable reflects the size of the fish price index relative to that of meat. A rise in meat prices would reduce this ratio, while a rise in fish prices would increase it. Hayakawa found that, for all fresh fish and shellfish, the price ratio had a coefficient of -0.33 (table 19). Thus, if meat prices were to rise, the ratio would fall and fish consumption would rise. For the low-quality fish group, the price coefficient was even more negative (-0.99). However, for the medium- and high-quality category, the coefficient was positive (0.42). This is hard to understand, since it means that a rise in meat prices would lead to lower consumption of the better types of fish. Hayakawa's results are interesting, and represent one of the only attempts to disaggregate the large expenditures on fish. Further attempts would be useful.

SUMMARY OF RESULTS

Studies reviewed here used a number of methods and data sets. The large number of results from the earlier studies and from the current study have been compared above. The summary that follows attempts to highlight results from the comparisons and to offer comments about methodological and data problems that continue to pose challenges for research in the area of Japanese meat demand.

Beef

Previous studies showed a high income elasticity for beef, suggesting a figure of between 1 and 2. My estimates tend to confirm this. I also found a higher elasticity when FBS data were used than when FIES data were used. Future researchers and forecasters may be better off using FBS data if they wish to make inferences about total Japanese beef consumption in the future, because FIES data refer only to home consumption, and the income-consumption relationship for home use may differ notably from that for other uses. Time series results showed no decline in the income elasticity from earlier periods. Cross-section results showed a decline until the midseventies, when they began to level off or increase.

The own-price elasticity for beef seems to be larger than that for other meats, and may be over 0.5 in absolute value. This result suggests that foreign suppliers may well find that a lower price increases Japanese beef consumption substantially if trade is liberalized. The data from the FIES do not include much imported beef, and imported beef became important in the FBS accounts only in the late seventies. Few estimates using FBS data from recent years exist, and if imported beef is not a close substitute for domestic Japanese beef, the high price elasticity may not apply to a situation of liberalized beef trade.

Most cross-price elasticity estimates for beef have not been significantly different from zero, or not trustworthy because own-price and income elasticity estimates were not reasonable. There is some fragile indication that pork is a substitute, but chicken prices seem to have little effect on beef consumption and the effects of fish price indices cannot be assessed, partly because different indices have been used. More work with disaggregated fish price variables could be enlightening, using FIES or FBS data. Estimates based on other data sources would be desirable in obtaining some confidence about the effects of pork and chicken prices.

Pork

In contrast to beef, the pork income elasticity has fallen during the past 30 years, as indicated in previous time series studies. My estimates, together with previous estimates, suggest a range of 0.5-1.5 for the income elasticity in more recent times. Cross-section results showed a decline in the income elasticity until 1975, and were stable thereafter, at about 0.4.

The own-price elasticity of pork also seems to have declined, and recent estimates suggest that it is less than 1. My results indicate that omission of cross prices biases the own-price elasticity estimate.

Estimates from this study and previous reports usually show that beef is a substitute for pork; the lowest cross-price elasticity estimate is 0.4. If the cross-price effect actually is strong, the implications for Japanese pork consumption and production of a liberalization of the beef trade, and consequent decline in the price of beef, could be serious. A drop in pork production would also lead to reduced feedstuff imports by Japan.

Chicken prices had either a positive coefficient or an insignificant one, so that chicken may be a substitute for pork. The extent of the elasticity is not evident. Fish price indices showed no consistent effect on pork consumption. Further estimation with disaggregated fish price variables would be of interest.

Chicken

The estimates of the income elasticity from previous time series studies and from this one are remarkably high, perhaps between 1 and 2. The 1982 MAFF study showed that single-equation estimates using double-log and semilog forms (elasticities calculated at the means) differed widely, with the latter estimate usually lower. For beef and pork, there was little difference. In contrast to time series results, cross-section income elasticity estimates for chicken meat were low, about 0.3, after declines that ended in the midseventies. The high estimates from the time series may be tied to the growth of fast food consumption of chicken.

The own-price elasticity estimates for chicken varied widely, but were usually less than 1 in absolute value for more recent periods. The use of different data would be welcome in helping to define the important own-price relationship for chicken. Cross-price elasticity estimates were often insignificant and otherwise showed little agreement. Because chicken consumption has increased over time and will probably rise more, it is important to try to learn more about price effects on it, and how the price of chicken affects other meats.

Fish

The definition of fish and shellfish consumption and price indices has received somewhat cavalier treatment in some studies. Fresh fish and shellfish are often assumed to substitute for fresh meat, but the evidence is weak. Income elasticities for fresh fish and shellfish are not significant, but are very high for salted and dried fish. The aggregate fresh fish and shellfish consumption appears to be price inelastic, while salted and dried fish consumption is price elastic. Estimates of cross-section income elasticities by MAFF for types of fish vary widely by species, suggesting that the different types compete with fresh meat in different ways. The use of disaggregated fish consumption and prices would be advisable in looking at cross-price relationships among meat and fish, but data limitations and multicollinearity may make such estimation difficult.

Estimation Methods and Problems

Japan's market for meats and fish is relatively large and growing fast. It is the subject of much commercial interest and has become the subject of international trade policy negotiations because of such interest. Partly in response to the needs of those who want to participate in the market or wish to guide it, a number of studies have estimated parameters of demand for meats and fish in Japan. In this report, I examined some of the studies that estimated price and income elasticities. An elasticity is a measure of a relationship and not a fixed quantity such as price or weight. An elasticity is expected to change over time and should be sensitive to the precise definition of the variables it measures. Nevertheless, the elasticity serves a purpose in describing the extent of a relationship, and, because analysts think that a relationship exists, they ought to be able to measure its extent with an elasticity.

In the case of meats and fish in Japan, the search for elasticity measures has not been very successful. Some conclusions about income elasticities can be made. Elasticities for beef, pork, and chicken are all positive, and certain ranges for them can be suggested. As for own-price elasticities, empirical results indicate that they are negative, although there is less information about their size than for income elasticities. For cross-price elasticities, little can be concluded despite many econometric attempts, including this study.

The main cause for the less-than-satisfying results obtained to date is multicollinearity of the price and income variables. Other causes, such as the incorrect specification of the functional form of demand relationships, omission of variables, choices of the wrong variables or deflators, undoubtedly have weakened results as well, but multicollinearity can persist even when other problems are dealt with.

From the large number of single-equation estimates reviewed in this study, it seems clear that simple log-linear, linear, or semilog equations will never yield consistent estimates of all the main elasticities. While principal components estimation, the use of lagged variables, simultaneous equation techniques, and demand systems techniques all deserve more attention from researchers, they, too, will be hampered by high multicollinearity.

Common prescriptions for multicollinearity are finding more data or using other information in estimation. Finding more annual, national data for Japan is not likely, but perhaps the use of more cross-sectional data, cross-sectional time

series, or regional and local data can shed further light on demand relationships. The use of additional information has been demonstrated by several studies reviewed in this paper, but not widely adopted. The use of demand systems incorporates restrictions implied by economic theory to reduce the number of parameters to be estimated, and offers a particularly interesting method for dealing with the thorny problem of estimating cross-price elasticities for meats and fish. However, even demand systems encounter difficulty in complying with certain economic arguments. Economic theory states that demand for a good is a function of all prices and income. The block independence apparently imposed by H. Sawada (1980) and Yuize (1979) is a severe restriction that deals with this problem, and less severe limits on cross-commodity effects would be desirable. The success of demand systems estimates cannot be fully determined without approximated confidence intervals for their elasticity estimates which have not always been provided. Calculation of standard errors in future reports would aid evaluation of demand systems estimates. Also, just as comparing a large number of simple single-equation estimates adds to confidence about the sign and range of an elasticity, having a large number of demand systems to compare would improve confidence in their results.

Postscript

Several papers of great interest have appeared during the long genesis of this report. Reviewing them would have delayed issuance of this report, so they were not included. A paper by M. Sawada (1984) develops and estimates a two-level food-demand system and addresses the issue of independence and separability, using a Rotterdam form. A translation was not available in time for review in this study, but that paper may provide more general results than the other Rotterdam models examined. At least three sets of estimates using the Almost Ideal Demand System have been released: those by Wahl, Hayes, and Williams; by Teal, Dickson, Porter, and Whiteford; and by Mount and Dyck. They are compared in a cursory fashion by Dyck. Mori, Lin, and Gorman have examined different types of beef in Japan and concluded that it is dangerous to treat beef as a homogeneous good; among other things, this means that using one own-price elasticity for all beef would be invalid.

Appendix table 1--Beef: Substitution relationships estimated by
previous studies, Japan

Author, publication date, and period	Beef variable	Pork variable	Type of equation	Elasticity
Kester, 1980:				
1960-70	Q, FBS	P, retail/CPI	linear	1/1.02
MAFF, 1982:				
1963-72	Q, FIES	P, retail/CPI	ln-ln	n.s.
	Q, FIES	P, retail/CPI	semiln	n.s.
1963-81	Q, FIES	P, retail/CPI	ln-ln	n.s.
	Q, FIES	P, retail/CPI	semiln	n.s.
1972-81	Q, FIES	P, retail/CPI	ln-ln	2/.12/
	Q, FIES	P, retail/CPI	semiln	n.s.
Sawada, 1980:				
1956-70	Q, FIES	P, FIES	Rotterdam	3/.51
Uchiyama, 1979:				
1964-77	Q, FIES	P, beef/P, pork, retail	ln-ln	4/7/12/-.73 4/8/12/-2.02
Williams, 1985:				
1962-82	Q, FBS-type	P, retail/CPI	ln-ln (2SLS)	5/12/.21
Yuize, 1966:				
1951-60	Q, FIES	P, FIES/CPI	ln-ln	.63
Yuize, 1979:				
1956-76	Q, FBS	P, retail	Rotterdam	2/6/.60

Author, publication date, and period	Beef variable	Chicken variable	Type of equation	Elasticity
Kester, 1980:				
1960-70	Q, FBS	P, retail/CPI	linear	1/1.04
MAFF, 1982:				
1963-72	Q, FIES	P, retail/CPI	ln-ln	n.s.
	Q, FIES	P, retail/CPI	semiln	n.s.
1963-81	Q, FIES	P, retail/CPI	ln-ln	n.s.
	Q, FIES	P, retail/CPI	semiln	n.s.
1972-81	Q, FIES	P, retail/CPI	ln-ln	n.s.
	Q, FIES	P, retail/CPI	semiln	n.s.
Rachman, 1974:				
1953-70	P, wholesale	Q, wholesale	linear, 2SLS	9/10/(-16.28)
Sanderson, 1978:				
1963-74	Q, FBS	P, retail/CPI	linear	10/2.14
Sawada, 1980:				
1956-70	Q, FIES	P, FIES	Rotterdam	3/.41
Williams, 1985:				
1962-82	Q, FBS-type	P, retail/CPI	ln-ln, 2SLS	4/12/.16
Yuize, 1979:				
1956-76	Q, FBS	P, retail	Rotterdam	2/5/0.

See notes at end of table.   Continued--

Appendix table 1--Beef: Substitution relationships
estimated by previous studies, Japan--Continued

Author, publication date, and period	Beef variable	Fish variable	Type of equation	Elasticity
Kester, 1980:				
1960-70	Q, FBS	fresh fish CPI/CPI	linear	1/-.20
Rachman, 1974:				
1953-70	P, wholesale	P, wholesale	linear, 2SLS	11/
Sawada, 1980:				
1956-70	Q, FIES	P, FIES	Rotterdam	3/4/.05
Williams, 1985:				
1962-82	Q, FBS-type	P, retail/CPI	ln-ln, 2SLS	5/12/.55
Yuize, 1979:				
1956-76	Q, FBS	P, retail	Rotterdam	2/6/.16

Notes: Q = Quantity. P = Price. n.s. = Not significant.
2SLS = two stage least squares. linear = equation of the form x = a + by.
ln-ln = equation of the form ln x = a + b(ln y).
semiln = equation of the form x = a + b(ln y).
1/ Equation includes prices of pork and chicken and a retail price index for fresh fish and shellfish.
2/ Neither standard errors nor details on significance test reported
3/ Equation includes prices of pork and chicken and a fish price index based on FIES implied retail prices for fresh fish, salted and dried fish, and whale meat; elasticities calculated at the means of the data.
4/ Equation also includes the price of beef as a separate variable.
5/ Equation includes a composite price of pork and chicken and an unspecified retail price index for fish.
6/ Equation includes prices of pork and chicken and an unspecified retail price index for fish; elasticities calculated at 1970 data.
7/ Short-run elasticity.
8/ Long-run elasticity.
9/ Equation uses an unspecified wholesale price index for fish, but does not include a pork variable.
10/ Elasticity calculated at the meats of data provided in the source.
11/ Equation includes the quantity of chicken, but no pork variable. A positive elasticity for the fish price is implied.
12/ Principal components method used.

Appendix table 2—Pork: Substitution relationships estimated by previous studies

Author, publication date, and period	Pork variable	Beef variable	Type of equation	Elasticity
Kester, 1980:				
1960–75	Q, FBS	P, retail/CPI	linear	1/.63
MAFF, 1982:				
1963–72	Q, FIES	P, retail/CPI	ln-ln	2/1.06
	Q, FIES	P, retail/CPI	semiln	3/.60
1963–81	Q, FIES	P, retail/CPI	ln-ln	2/1.18
	Q, FIES	P, retail/CPI	semiln	3/.52
1972–81	Q, FIES	P, retail/CPI	ln-ln	2/.46
	Q, FIES	P, retail/CPI	semiln	n.s.
Rachman, 1974:				
1953–70	P, wholesale	P, wholesale	linear, 2SLS	4/
Sawada, 1980:				
1956–70	Q, FIES	P, FIES	Rotterdam	3/5/.61
Uchiyama, 1979:				
1964–77	Q, FIES	P, retail/CPI	ln-ln	9/11/.41
				10/11/.72
Williams, 1985:				
1962–82	Q, FBS-type	P, retail/CPI	ln-ln, 2SLS	6/11/.58
Yuize, 1966:				
1951–60	Q, FIES	P, FIES/CPI	ln-ln	1.54
Yuize, 1979:				
1956–76	Q, FBS	P, retail	Rotterdam	2/7/.43

Author, publication date, and period	Pork variable	Chicken variable	Type of equation	Elasticity (Flexibility)
Filippello, 1968:				
1953–64	P, wholesale/CPI	Q, FBS	ln-ln, 3SLS	8/(.08)
Kester, 1980:				
1960–75	Q, FBS	P, retail/CPI	linear	1/.28
MAFF, 1982:				
1963–72	Q, FIES	P, retail/CPI	ln-ln	n.s.
	Q, FIES	P, retail/CPI	semiln	n.s.
1963–81	Q, FIES	P, retail/CPI	ln-ln	2/1.57
	Q, FIES	P, retail/CPI	semiln	3/.82
1972–81	Q, FIES	P, retail/CPI	ln-ln	2/.94
	Q, FIES	P, retail/CPI	semiln	3/.82
Sawada, 1980:				
1956–70	Q, FIES	P, FIES	Rotterdam	3/5/.23
Williams, 1985:				
1962–82	Q, FBS-type	P, retail/CPI	ln-ln, 2SLS	6/11/.25
Yuize, 1979:				
1956–76	Q, FBS	P, retail	Rotterdam	2/7/.20

See notes at end of table.   Continued--

Appendix table 2--Pork: Substitution relationships estimated by previous studies—Continued

Author, publication date, and period	Pork variable	Fish variable	Type of equation	Elasticity (Flexibility)
Filippello, 1968:				
1953-64	P, wholesale/CPI	Q, FBS	ln-ln, 3SLS	8/(.61)
Rachman, 1974:				
1953-70	P, wholesale	P, wholesale	linear, 2SLS	4/
Sawada, 1980:				
1956-70	Q, FIES	P, FIES	Rotterdam	3/5/.35
Yuize, 1979:				
1956-76	Q, FBS	P, retail	Rotterdam	2/7/.01

Notes: Q = quantity. P = Price. n.s. = not significant.
ln-ln = equation of the form ln x = a + b(ln y).
linear = equation of the form x = a + by. 2SLS = two stage least squares.
semiln = equation of the form x = a + b(ln y). 3SLS = three stage least squares.
1/ Equation includes the prices of beef and chicken.
2/ Neither standard errors nor details of significance tests were reported.
3/ Elasticities evaluated at the means of the data.
4/ Equation includes the price of beef and an unspecified wholesale price index for fish A positive elasticity is implied.
5/ Equation includes prices of pork and chicken and a fish price index based on FIES implied retail prices for fresh fish, salted and dried fish, and whale meat.
6/ Equation includes an unspecified retail price index for fish and a composite price of beef and chicken.
7/ Equation includes the prices of beef and chicken and an unspecified retail price index for fish; elasticities evaluated at 1970 data.
8/ Equation includes the quantities of chicken and fish, but not beef.
9/ Shortrun elasticity.
10/ Longrun elasticity.
11/ Principal components method used.

Appendix table 3--Chicken: Substitution relationships estimated
by previous studies

Author, publication date, and period	Chicken variable	Beef variable	Type of equation	Elasticity
MAFF, 1982:				
1963-72	Q, FIES	P, retail/CPI	ln-ln	1/1.09
	Q, FIES	P, retail/CPI	semiln	2/.38
1963-81	Q, FIES	P, retail/CPI	ln-ln	1/.93
	Q, FIES	P, retail/CPI	semiln	n.s.
1972-81	Q, FIES	P, retail/CPI	ln-ln	n.s.
	Q, FIES	P, retail/CPI	semiln	n.s.
Rachman, 1974:				
1953-70	P, wholesale	P, wholesale	linear, 2SLS	3/
Sawada, 1980:				
1956-70	Q, FIES	P, FIES	Rotterdam	2/4/.40
Williams, 1985:				
1962-82	Q, FBS-type	P, retail/CPI	ln-ln, 2SLS	5/.36
Yuize, 1979:				
1956-76	Q, FBS	P, retail	Rotterdam	1/6/0

Author, publication date, and period	Chicken variable	Pork variable	Type of equation	Elasticity
Kester, 1980:				
1960-75	Q, FBS	Pchicken/Ppork	linear	7/.65
MAFF, 1982:				
1963-72	Q, FIES	P, retail/CPI	ln-ln	1/-1.17
	Q, FIES	P, retail/CPI	semiln	n.s.
1963-81	Q, FIES	P, retail/CPI	ln-ln	1/-.67
	Q, FIES	P, retail/CPI	semiln	n.s.
1972-81	Q, FIES	P, retail/CPI	ln-ln	1/-.30
	Q, FIES	P, retail/CPI	semiln	n.s.
Sawada, 1980:				
1956-70	Q, FIES	P, FIES	Rotterdam	2/4/.53
Williams, 1985:				
1962-82	Q, FBS-type	P, retail/CPI	ln-ln, 2SLS	5/10/.20
Yuize, 1979:				
1956-76	Q, FBS	P, retail	Rotterdam	1/6/.35

See notes at end of table.   Continued--

Appendix table 3--Chicken: Substitution relationships estimated
by previous studies--Continued

Author, publication date, and period	Chicken variable	Fish variable	Type of equation	Elasticity
Rachman, 1974:				
1953-70	P, wholesale	P, wholesale	linear, 2SLS	3/
Sawada, 1980:				
1956-70	Q, FIES	P, FIES	Rotterdam	2/4/.26
Uchiyama, 1979:				
1964-77	Q, FIES	P, retail/CPI	ln-ln	8/10/.41
				9/10/.66
Yuize, 1979:				
1956-76	Q, FBS	P, retail	Rotterdam	1/6/.37

Notes: n.s. = not significant. ln-ln = equation of the form ln x = a +
b(ln y). semiln = equation of the form x = a +b(ln y). linear = equation of
the form x = a + by. 2SLS = two stage least squares.
1/ Neither standard errors nor details on significance tests were reported.
2/ Elasticity calculated at the means of the data.
3/ Equation includes the price of beef and a retail price index for fish. A
positive price elasticity is implied.
4/ Equation includes prices of pork and chicken and a fish price index based
on FIES implied retail prices for fresh fish, salted and dried fish, and
whale meat.
5/ Equation includes price index for fish and a composite price of beef and
pork.
6/ Equation includes the prices of pork and beef and an unspecified retail
price index for fish; elasticities calculated at 1970 data.
7/ The explanatory variables are income and the price of chicken divided by
the price of pork.
8/ Shortrun elasticity.
9/ Longrun elasticity.
10/ Principal components method used.

Appendix table 4--Data used in the updated regressions

Year	Food Balance Sheet quantities, kilograms/person/year 1/			:	Family Income and Expenditure Survey quantities, 100 grams/household/year 2/		
	Beef	Pork	Chicken	:	Beef	Pork	Chicken
1967	1.2	4.6	2.4		60.40	129.67	65.13
1968	1.4	4.3	2.6		57.34	130.36	68.49
1969	1.8	4.4	3.3		63.49	126.00	78.27
1970	2.0	4.7	3.8		67.82	140.03	86.54
1971	2.3	5.1	4.3		72.43	151.37	87.99
1972	2.4	5.6	4.7		77.08	158.41	95.82
1973	2.3	6.4	5.1		70.51	173.61	102.32
1974	2.5	6.5	5.1		74.23	185.60	104.63
1975	2.5	6.5	5.2		77.84	182.16	111.21
1976	2.7	7.7	5.8		80.45	187.67	118.08
1977	3.0	8.3	6.5		83.90	194.50	121.95
1978	3.3	8.7	7.1		93.15	197.15	130.39
1979	3.4	9.6	7.5		94.25	203.68	138.64
1980	3.5	9.6	7.7		91.53	208.67	145.05
1981	3.6	9.6	7.8		94.10	197.85	140.61
1982	3.9	9.5	8.3		98.54	196.61	146.54
1983	4.2	9.6	8.6		96.87	190.28	142.80

Year	Retail prices in the Ku area of Tokyo, yen/100 grams 3/			CPI for all goods 3/	CPI for fresh fish and shellfish 4/	National income per person, 1,000 yen 3/
	Beef	Pork	Chicken			
1967	124	71	--	35.4	--	355
1968	142	85	--	37.3	--	412
1969	135	96	--	39.3	--	478
1970	137	91	--	42.3	--	570
1971	147	93	71	44.9	37.4	615
1972	151	99	72	46.9	38.9	697
1973	198	112	80	52.4	43.7	842
1974	245	124	96	65.2	57.1	987
1975	271	155	99	72.9	64.9	1079
1976	316	168	111	79.7	75.4	1204
1977	315	159	113	86.1	89.0	1305
1978	309	157	103	89.4	91.0	1424
1979	315	150	99	92.6	94.9	1517
1980	339	145	114	100.0	100.0	1634
1981	336 5/	153	120	104.9	102.8	1710 6/
1982	342 5/	157	118	107.7	110.9	1772 6/
1983	351 5/	163 5/	119 5/	109.7 5/	110.4	1823 6/

See notes at end of table.   Continued--

Appendix table 4--Data used in the updated regressions--Continued

Year	Family Income and Expenditure Survey 2/						
	Total living expenditures, yen/house-hold/year	Prices, yen/100 grams					Number in household
		Beef	Pork	Chicken	Whale	Fresh fish and shellfish	
1967	684,855	101.65	64.79	60.37	29.95	29.05	4.15
1968	763,285	111.97	73.77	63.13	32.05	32.52	4.07
1969	844,634	116.33	83.69	64.30	37.53	36.83	3.99
1970	954,369	121.52	82.09	64.64	48.29	44.20	3.98
1971	1,049,699	129.07	84.54	67.83	55.31	51.77	3.96
1972	1,152,309	140.85	90.47	68.66	60.55	56.89	3.93
1973	1,345,394	183.67	101.66	78.00	67.21	64.47	3.91
1974	1,632,286	212.23	113.40	93.95	82.67	78.90	3.90
1975	1,895,786	238.50	138.52	102.45	102.25	90.29	3.89
1976	2,097,484	267.28	150.58	111.07	115.77	102.08	3.84
1977	2,285,961	272.74	146.37	110.87	128.97	114.63	3.82
1978	2,420,575	275.48	144.15	101.81	142.49	118.50	3.83
1979	2,576,363	284.49	137.55	97.41	151.70	124.00	3.83
1980	2,766,812	309.34	137.20	99.11	161.25	129.29	3.82
1981	2,880,163	309.99	147.16	104.13	160.07	135.21	3.79
1982	3,038,024	314.38	150.15	103.12	165.70	142.97	3.78
1983	3,114,247	314.08	153.47	102.28	184.49	139.26	3.76

CPI = Consumer price index.   -- = Not used.
1/ Source of the data was the Statistical Yearbooks of the Ministry of Agriculture, Forestry, and Fisheries, Japan, various issues, published by the Statistics and Information Department, MAFF.
2/ Source of the data was the Annual Report on the Family Income and Expenditure Survey, 1984, table 16, published by the Statistics Bureau, Management and Coordination Agency, Japan.
3/ Source of the data was the Japan Statistical Yearbook, 1983, published by the Statistics Bureau, Prime Minister's Office, except as noted.
4/ Source of the data was Monthly Statistics of Japan, various issues, published by the Statistics Bureau, Management and Coordination Agency.
5/ Source of the data was 4/, Feb. 1985.
6/ Calculated from data in 5/.

Appendix table 5--Data used to obtain cross section elasticities:
Household data from the 1979 National Survey of Family Income and Expenditure 1/

Yearly income group, income range in 1,000 yen	Number in household	Average income in 1,000 yen	Quantity consumed per month, in kilograms				
			Beef	Pork	Chicken	Ground meat	Ham
Under 1,000	2.72	689	452	1010	865	25	192
1,000-1,200	2.57	1070	387	1003	802	13	171
1,200-1,400	2.78	1273	495	1150	918	20	203
1,400-1,600	2.96	1491	524	1176	971	25	212
1,600-1,800	3.06	1683	501	1223	933	28	209
1,800-2,000	3.32	1874	607	1484	1093	28	245
2,000-2,400	3.45	2170	631	1478	1040	36	265
2,400-2,800	3.65	2571	665	1606	1109	41	309
2,800-3,200	3.77	2980	730	1674	1165	45	325
3,200-3,600	3.87	3388	755	1815	1236	46	350
3,600-4,000	3.95	3765	804	1854	1274	42	373
4,000-4,500	4.00	4189	875	1968	1350	45	394
4,500-5,000	4.05	4699	937	1961	1351	45	400
5,000-5,500	4.07	5180	982	2086	1452	48	408
5,500-6,000	4.09	5703	1007	2103	1451	42	417
6,000-7,000	4.22	6386	1095	2067	1462	42	428
7,000-8,000	4.28	7379	1138	2212	1451	51	454
8,000-10,000	4.32	8747	1345	2172	1536	45	466
Over 10,000	4.41	13776	1611	2240	1587	60	463

Yearly income group, income range in 1,000 yen	Quantity consumed per month				
	Sausage, kilograms	Milk, liters	Butter, kilograms	Cheese, kilograms	Eggs, pieces
Under 1,000	138	4.98	25	61	45.6
1,000-1,200	126	4.85	22	47	45.0
1,200-1,400	130	4.83	22	51	47.6
1,400-1,600	145	5.53	30	69	50.7
1,600-1,800	180	5.63	26	57	50.1
1,800-2,000	204	6.73	33	76	56.5
2,000-2,400	210	7.41	37	92	57.8
2,400-2,800	245	8.04	42	98	59.8
2,800-3,200	268	8.50	46	109	61.3
3,200-3,600	279	8.83	48	118	65.5
3,600-4,000	296	8.84	56	125	65.7
4,000-4,500	298	9.02	60	127	67.6
4,500-5,000	303	9.17	61	146	68.8
5,000-5,500	304	9.05	68	135	69.3
5,500-6,000	305	9.91	65	142	70.3
6,000-7,000	307	9.96	79	139	73.5
7,000-8,000	300	9.90	75	146	72.2
8,000-10,000	314	10.39	99	154	73.5
Over 10,000	319	11.47	118	181	73.4

1/ Data from pp. 52-58 in Statistics Bureau, 1981.

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