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FAO ECONOMIC AND SOCIAL DEVELOPMENT PAPER

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RÉSUMÉ EN FRANÇAIS
RESÚMEN EN ESPAÑOL

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FOREWORD

Japan, as one of the largest importers of foods and agricultural products, is a big player in the world agricultural market. Over the last several decades, changes in the Japanese food consumption pattern have altered the food balance sheets in Japan. Japanese have been eating less rice but more meat, and all these trends have important implications for predicting the future agricultural trade patterns between Japan and its trading partners. Understanding Japanese food demand structure is critical for the assessment of Japan's future food balance and its implied effects on the world food market.

The present study by Chern, Ishibashi, Taniguchi, and Tokoyama represents one of the most comprehensive investigations on Japanese food demand structure. There have been relatively few studies on food demand in Japan in the literature. Therefore, the study provides timely and useful information for assessing the future demand for food in this country. There are several unique features of this study. First, the authors use household survey data, which have been rarely used in the study of food demand in Japan. The use of household data enables the authors to model food demand with demographic variables. The estimates of income elasticity obtained from cross-sectional household data should be more credible than those obtained from time-series data. Second, the study employs alternative modelling and estimation procedures. The authors compare the results from single equation and demand system estimation, and from different estimators dealing with the problem associated with households having zero consumption of certain food items. The estimated demand elasticities are useful for those who work on various forecasting models including Japan as well as for agricultural policymakers.

The study focuses on rice and meat, two of the most important food categories for assessing the Japanese food consumption pattern. Rice is one of the most contested agricultural products in the trade negotiation under the World Trade Organization (WTO). Frequently rice in Asian countries is considered as a staple food. This study provides evidence on whether or not rice has become an inferior good in Japan. The meat model will help us understand the important factors affecting Japanese meat consumption pattern. These econometric results should be useful for assessing the future trend of world food consumption patterns because the Japanese consumption pattern can be considered as a preceding model for other Asian countries.

This report contains much descriptive statistics and econometric results. The descriptive statistics by demographic and income groups provide a qualitative assessment of the Japanese food consumption pattern while the econometric results can be used for a quantitative assessment. This study represents only another milestone in analysing the Japanese food demand structure. Since no study can be perfect, the results contained in this report need further validation. Hopefully, this study would motivate and generate more analyses on food demand estimation in Japan and perhaps, more debates on those key demand elasticities for rice, meat and other food items.

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Abstract

The objectives of this research are to analyse food consumption patterns in Japan and to conduct an econometric analysis of Japan's food demand structure. This report pays particular attention to the questions as to whether or not rice is an inferior good (as previous researchers have claimed) and to what extent Japanese food consumption patterns have been Westernized. It is based on the cross-sectional household data of the Annual Report on the Family Income and Expenditure Survey (FIES) for 1997, compiled by the Statistics Bureau of the Management and Coordination Agency in Japan. A total of 95 223 observations were used for 11 major food items. The food items comprised non-glutinous rice, bread, noodles, fresh fish and shellfish, fresh meat, milk, eggs, fresh vegetables, fresh fruits, fats and oil, and food away from home (FAFH). For the meat model, a total of 94 200 observations were used, and the items of interest are beef, pork, poultry, ground meat, ham, sausage and bacon.

In order to deal with the zero-consumption problem associated with household-level microdata, various single-equation models were applied: the Working-Leser model estimated by ordinary least squares (OLS); Heckman's sample selection model; and the Tobit model. For a complete demand system analysis, the linearly approximated almost ideal demand system (LA/AIDS) and the non-linear almost ideal demand system (AIDS) were applied.

Empirical results from the 11 major food items show that the expenditure elasticity of rice is positive and close to one. This proves that rice is consumed in Japan as a normal good, contrary to the results of previous studies. Marshallian uncompensated and Hicksian compensated own-price elasticities for rice are highly elastic in all models, while the own-price elasticity for meat is relatively price-inelastic. Fresh meats and rice are mild complements in all models, although fresh fish and rice show mixed results with respect to their substitution pattern.

Results from the meat model show that the expenditure elasticity of beef is greater than unity, while other meat products are expenditure inelastic. In addition, meat expenditure and price elasticities are very similar to those of Western nations. This study shows that the Japanese meat consumption pattern has become Westernized.

Résumé

Cette étude a pour but d'analyser les modes de consommation alimentaire et d'effectuer une étude économétrique de la structure de la demande de produits vivriers au Japon. On cherche tout particulièrement à établir si le riz est effectivement un bien inférieur comme l'ont déterminé d'autres chercheurs et dans quelle mesure les habitudes alimentaires des japonais se sont-elles occidentalisées.

Nous nous sommes basés sur les données transversales des ménages, Annual Report on the Family Income and Expenditure Survey (FIES) de 1997, compilée par le Bureau des statistiques, de l'organisme de gestion et de coordination du Japon. Pour les 11 principaux articles alimentaires, un total de 95.223 observations a été utilisé dans cette estimation. Les articles alimentaires sont les suivants : riz non gluant, pain, pâtes, poisson frais et fruits de mer, viande fraîche, lait, œufs, légumes frais, fruits frais, graisses et huile et alimentation hors de la maison. En ce qui concerne la viande, un total de 94.200 observations a été incorporé à l'estimation et les principaux articles sont le bœuf, le porc, la volaille, la viande hachée, le jambon, les saucisses, et le lard maigre. Afin d'aborder le problème de consommation zéro associé aux microdonnées au niveau des ménages, plusieurs modèles à équation simple ont été appliqués : le modèle Working-Leser estimé par la méthode OLS, le modèle des échantillons sélectifs de Heckman et le modèle Tobit. Pour l'analyse du système complet de la demande, nous avons appliqué le système LA/AIDS (linearly approximated almost ideal demand system), ainsi que le systèmeAIDS (nonlinear almost ideal demand system).

Les résultats empiriques pour les 11 principaux articles alimentaires démontrent que l'élasticité - dépenses pour le riz est positive et proche de un. Ceci démontre que le riz consommé au Japon est un bien normal, contrairement aux résultats émanés d'études antérieures. Les élasticités- prix propre non-compensées de type marshallien et compensées de type hicksien du riz sont très élastiques dans tous les modèles, alors que d'autre part, l'élasticité prix propre de la viande a une élasticité-prix relativement faible. La viande fraîche et le riz sont des composantes moyennes dans tous les modèles, alors que le poisson frais et le riz affichent des résultats mitigés par rapport à leur mode de substitution.

Les résultats pour les produits carnés indiquent que l'élasticité de la dépense du bœuf est supérieure à l'unité, alors que les autres produits carnés ne présentent aucune élasticité. Par ailleurs, les élasticités de la dépense et du prix semblent très similaires à celles des nations occidentales. L'étude démontre que le mode de consommation de viande des Japonais s'est donc occidentalisé.

Resumen

El objetivo de esta investigación es estudiar los patrones de consumo de alimentos y llevar a cabo un análisis econométrico de la estructura de la demanda por alimentos en Japón. En este estudio, hemos puesto especial atención a las interrogantes relativas a si el arroz constituye un producto inferior, tal como lo han planteado investigadores abocados a este tema anteriormente y en qué medida se han occidentalizado los patrones de consumo de alimentos de los japoneses.

Para estos efectos, utilizamos los datos de corte transversal de los hogares, Informe Anual sobre el Estudio de Ingreso y Gasto Familiar (FIES) de 1997, recopilados por Statistics Bureau, Management and Coordination Agency (Organismo de coordinación, administración y oficina de estadísticas) de Japón. Para los 11 principales alimentos, el número total de observaciones utilizadas para fines de estimación es de 95.223. Los alimentos son arroz sin almidón, pan, fideos, pescado y mariscos frescos, carnes frescas, leche, huevos, vegetales frescos, grasas y aceite y alimentos ingeridos fuera del hogar. En el caso de las carnes, el número total de observaciones utilizadas es de 94.200 y los productos de interés son vacuno, cerdo, ave, carne molida, jamón, salchicha y tocino. Con el fin de abordar el problema de cero consumo asociado a microdatos a nivel de hogares, se aplicaron diversos modelos uniecuacionales: El modelo Working-Leser estimado mediante OLS (método de mínimos cuadrados ordinarios), el modelo de selección de muestras de Heckman y el modelo Tobit. Para realizar un análisis completo del sistema de demanda, aplicamos la aproximación lineal al sistema de demanda casi ideal (LA/AIDS). Además, aplicamos el sistema no linear de demanda casi ideal (AIDS).

Los resultados empíricos de los 11 principales alimentos demuestran que la elasticidad del gasto del arroz es positiva y cercana a uno. Lo anterior demuestra que el arroz consumido en Japón es un bien normal, lo que contrasta con los resultados de los estudios anteriores. Las elasticidades de propio precio compensado de Hicks y no compensado de Marshall para el arroz son sumamente elásticas en todos los modelos. Por otra parte, la elasticidad de propio precio de la carne es relativamente inelástica respecto del precio. Las carnes frescas y el arroz son complementos moderados en todos los modelos, sin embargo, el pescado fresco y el arroz arrojan resultados combinados con respecto a su patrón de sustitución.

Los resultados de las carnes evidencian que la elasticidad del gasto del vacuno es mayor que la unidad, mientras que otros productos cárneos son inelásticos. De manera adicional, las elasticidades relativas a precio y gasto son muy similares a las de las naciones occidentales. Este estudio demuestra que el patrón de consumo de carne de los japoneses se ha occidentalizado.

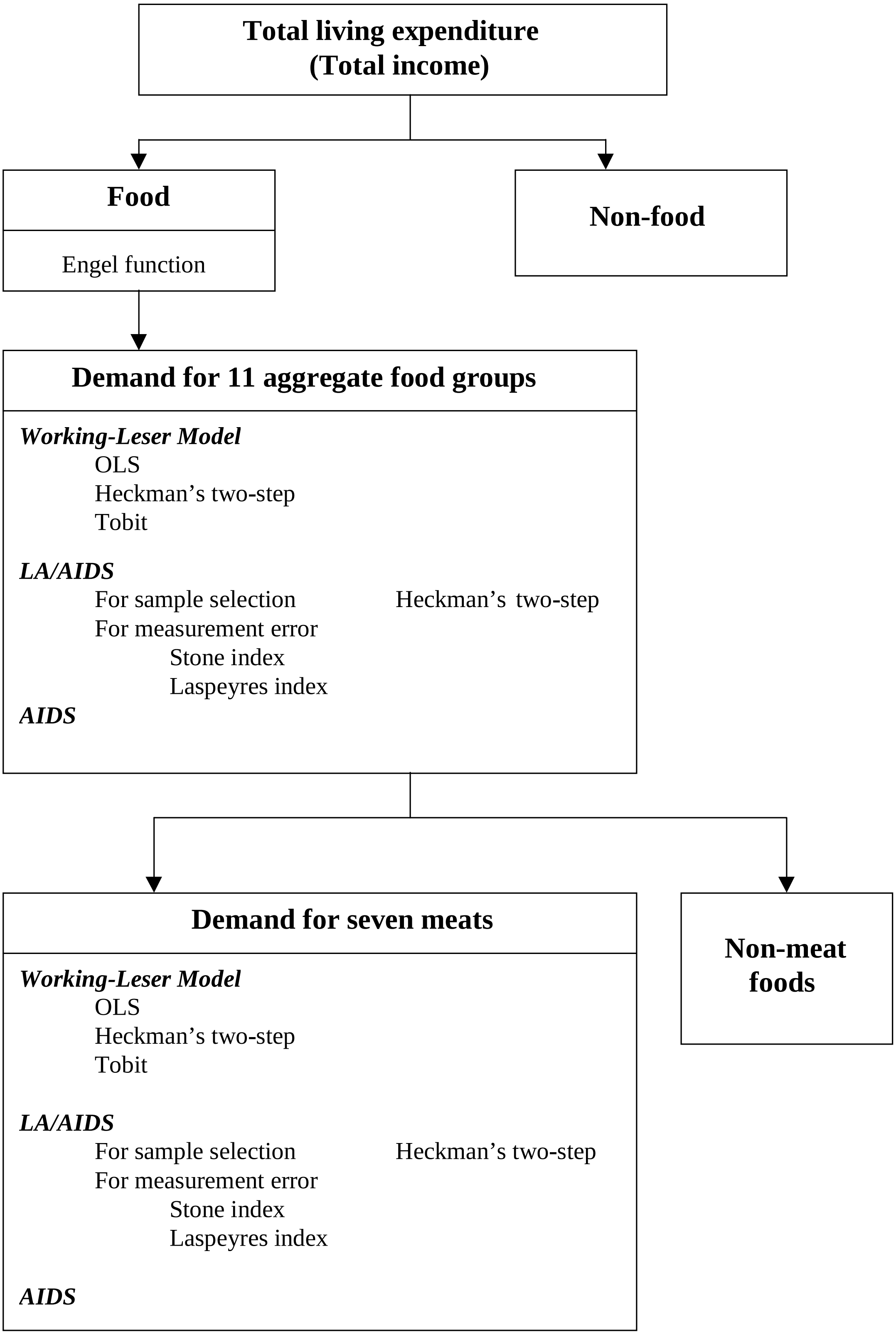
1. Introduction

The pattern of Japanese food consumption has been undergoing dramatic changes over the last 30 years. While the consumption of meats, particularly beef, and dairy products has been increasing, that of rice, fish, fresh fruits and fresh and processed vegetables has decreased. Many economists have attributed these changes to such factors as higher household income, an ageing population and a more Westernized lifestyle. It is clear that many factors have influenced the Japanese food consumption pattern, and an understanding of these factors is very important for assessment of the agricultural products market in Japan. As Japan is one of the largest agricultural importing countries, changes to its food consumption pattern will directly affect world agricultural trade. Such questions as whether rice is an inferior good are important for evaluating the significance of Japanese domestic rice policy in the forthcoming World Trade Organization (WTO) negotiations. This report attempts to provide econometric evidence for answering such questions, using cross-sectional data analysis.

The objectives of the report are to analyse food consumption patterns and to conduct econometric analyses of the food demand structure in Japan. Specifically, the authors use household data from the Family Income and Expenditure Survey (FIES) of 1997, which they obtained from the Statistics Bureau of the Management and Coordination Agency in collaboration with the National Research Institute of Agricultural Economics (NRIAE) in Tokyo. The report is relatively unusual because it is based on household-level data, while most literature on the analysis of food demand in Japan uses aggregate data at the national level or data that is aggregated by demographic group. The use of household data makes it possible to analyse the impacts of important demographic variables that affect food consumption patterns in Japan. The large number of households surveyed by the FIES provides higher degrees of freedom in econometric estimation than many previous studies that use time series data. This is particularly important for estimating the income elasticities of such important staple foods as rice. The household data should be able to shed more light on such issues as whether or not rice is an inferior good or whether food demand in Japan changes according to age group.

Two specific food demand studies were undertaken for this report: 1) the demand for 11 aggregate food groups, including rice; and 2) the demand for seven meats. Figure 1.1 gives an overview of the two food demand subsystems and of various econometric models that were estimated for and are presented in this report. These models are discussed in detail in Chapter 3; descriptive statistics describing food consumption patterns in Japan, the survey, the models used, econometric estimation results, and estimated demand elasticities and their implications are also presented.

Figure 1.1: Modelling food demand in Japan



2. Family income and expenditure survey 1997

SURVEY DESCRIPTION

The Family Income and Expenditure Survey (FIES, *Kakei Chosa Nenpo*), conducted by the Statistics Bureau of the Management and Coordination Agency, is one of two comprehensive consumer expenditure surveys in Japan.[1] Its purposes are to create consumer price indices and to collect information on household income and expenditure for policy planning purposes.

The survey covers households designated as appropriate households by the Statistics Bureau. Appropriate households include all households except those engaged in agriculture, forestry and fishery, and one-person households.[2] In the 1990 population census, there were about 29 million appropriate households (71.3 percent of the total 40.67 million households). From these, sample households were chosen by a stratified three-stage sampling method.

The FIES surveys about 8 000 households each month. Each household participates in the survey for a period of six consecutive months, and one-sixth of the participating households are replaced by new ones each month. Unlike the United States' Consumer Expenditure Survey (CES),[3] the Statistics Bureau of Japan does not release household identification numbers; it is therefore not possible to track individual households throughout a survey period. At the beginning of the survey period, data on household characteristics are collected, such as household composition, total annual household income and housing tenure. Then, twice a month for the following six months, each household is asked to report its expenditure on and the amount purchased of each of the survey commodities.

One of the recent trends in Japanese household food consumption patterns is "Westernization". Table 2.1 shows how the quantities of major food commodities purchased in Japan changed between 1975

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[1] The other survey, the National Survey of Family Income and Expenditure (NSFIE, "*Zenkoku Shohi Jittai Chosa*"), is conducted by the same agency every five years. Its sample size is 60 000 households, including single-person households. It covers ten aggregate expenditure categories, but no detailed food categories.

[2] The number of one-person households in Japan increased by 19.7 percent from 1990 to 1995, and is still increasing. At 11.24 million, they accounted for 25.6 percent of all households in the 1995 census. These increases are caused by a growing number of young single people setting up their own households rather than staying in the parental home until marriage, and a growing number of elderly people who live alone rather than joining their children's households as part of the extended family. Thus, the distribution of one-person households is V-shaped. Responding to this increase, in January 1995, the Statistics Bureau started to conduct a monthly survey called The Income and Expenditure Survey for One-Person Households (IES). Several characteristics of one-person households can be noted (the following statistics were taken from the 1998 IES): the average age of the reference person is younger (48.6 years) than in the FIES; about half of the sample is female; of these 50 percent are more than 60 years of age; the male sample is biased towards the younger generation; about 60 percent of households are workers' households; only the average income for workers' households is obtained (283 443 yen per month); the saving rate is slightly higher (29.2 percent) than in the FIES; and housing costs are the only expenditure for which one-person households spend more than the nominal level for average household in the FIES. One-person households differ greatly from their corresponding sex and age groups in the FIES in terms of their consumption of food outside the home and prepared food – one-person households are the major consumers of those goods.

[3] The CES is a representative consumer survey in the United States and is conducted by the Bureau of Labor Statistics. It consists of two independent surveys: the CES Dairy Survey, which has characteristics similar to those of the FIES; and the CES Interview Survey, which is more like the NSFIE.

and 1997. It is noticeable that purchases of traditional Japanese foods have tended to decrease in quantity over the last 30 years, while purchases of non-traditional goods have increased.

TABLE 2.1
Changes in quantities purchased: 1970–1995

Decrease		Neutral	Increase	
Cereal		**Oil/fats**	**Meat**	**6%**
Non-glutinous rice	-50%		Beef	41%
Fish	**-24%**		Pork	-13%
Fresh vegetables	**-24%**		Poultry	8%
Fresh fruits	**-45%**		Ground beef	19%
Processed vegetables			**Dairy**	
Dried mushrooms	-60%		Milk	20%
Bean curd	-10%		**Non-alcoholic beverages**	
Pickled radishes	-46%		Black Tea	13%
Non-alcoholic beverages			Coffee	143%
Green tea	-33%			

Source: FIES, various issues.

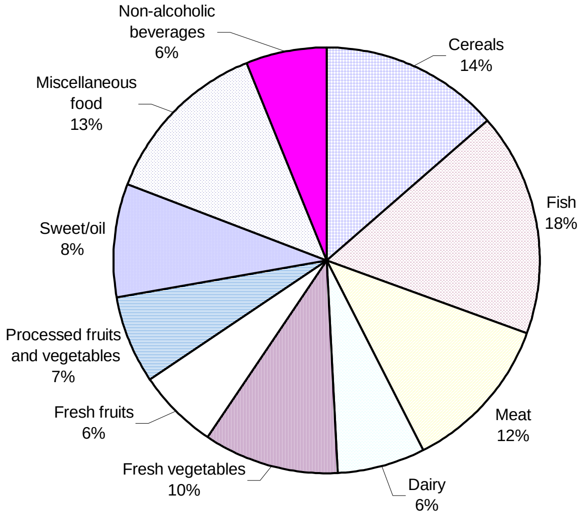
The characteristics of Japanese household food expenditure patterns can be compared with those of United States patterns, which may be considered a typical Western country. The statistics and graphs in this report are based on the following tables: Table 17 in the FIES 1997 Annual Report, published by the Japanese Statistics Bureau; and the tables on pages 71 and 72 of the 1997 CES Codebook, provided by the United States Bureau of Labor Statistics.[4]

The characteristics of households in the FIES reflect Japan's rapidly ageing population. Compared with the United States survey, in 1997:

- the average reference person in Japan was older (51.6 years of age, compared with 47.7 years in the United States);
- a higher percentage of households in Japan included children under 18 years of age (0.78 percent, compared with 0.69 percent in the United States);
- the percentage of households with at least one member over 65 years of age was also higher in Japan (0.47 percent, compared with 0.31 percent in the United States);
- the average household in Japan was larger (3.34 members, compared with 2.54 in the United States);
- the average household in Japan had more wage earners, (1.54 earners, compared with 1.41 in the United States);
- more Japanese households had housing tenure (72.4 percent, compared with 61.4 percent in the United States);
- average household disposable income was higher in Japan (497 036 yen – or US$4 082 – per month, compared with US$3 160 in the United States);
- the saving rate per household was higher in Japan (28 percent, compared with 6.9 percent in the United States).

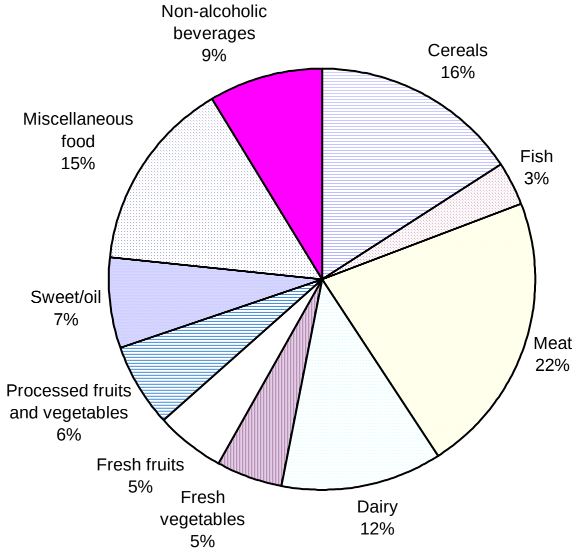
[4] In this report, data from the CES Dairy Survey are used. Note that the CES includes one-person households.

Figure 2.1: Food expenditure shares in Japan in 1997



Source: FIES, 1997.

Figure 2.2: Food expenditure shares in the United States in 1997



Source: CES, 1997.

Figures 2.1 and 2.2 show the food expenditure shares of ten aggregate food groups for home consumption in Japan and the United States, respectively. The expenditure share for cereals in 1997 was almost the same in the two countries. However, while about 50 percent of Japan's cereal expenditure was on rice, the United States' rice expenditure was negligible. Total expenditure shares of meat and fish were about the same in both countries, but the ratios of meat to fish expenditures were significantly different. The shares of fish and vegetables were significantly higher in Japan, while the shares of fresh fruits were almost the same in both countries. The expenditure shares of processed fruits and vegetables were also about the same; but 95 percent of this expenditure in Japan was for processed vegetables, while only 40 percent was in the United States. The dairy product share was significantly lower in Japan. Other products, such as miscellaneous foods and non-alcoholic beverages, had almost the same share levels in both countries. Combining these results, the following general observations can be made regarding the food consumption patterns of the two countries:

- Foods that had a significantly higher expenditure share in Japan than in the United States have decreased their shares over time in Japan.
- Foods that had a lower share in Japan than in the United States have increased their shares over time in Japan.

As a result, for some foods, the differences in expenditure shares between the two countries have declined in recent years.

In summary, although the Westernization of Japanese food consumption patterns can be observed, there still seems to be a wide gap between the expenditure patterns of Japanese and United States households. However, it should also be noted that differences in expenditure share reflect differences in relative food prices, as well as differences in the quantities consumed. Therefore, the actual food demand structures of Japan and the United States may not be as diverse as they appear from the observed expenditure share patterns, especially those for fish and meat, which are relatively expensive food groups. Another significant difference is in the expenditure share for food away from home (FAFH) (excluding alcoholic beverages), which was 18.7 percent in Japan and 29.9 percent in the United States.

This report also uses some other important characteristics of the survey data. First, there is the issue of seasonality. From monthly data, it can be observed that December is irregular in terms of both expenditures and income. In particular, food expenditure in December is significantly higher than in other months, apparently owing to preparations for the New Year feast. Second, there are regional differences. Total household income and expenditures tend to be higher in Kanto and lower in Hokkaido and Okinawa. More on these characteristics will be discussed in later sections of the report.

Although the original survey covered in detail all of the commodities that each household purchased, the data used in this report have been aggregated according to food categories and household characteristics. Data on detailed food categories, except for FAFH, include expenditures and quantities purchased. For FAFH and other non-food categories, data on the quantities purchased are not available.

DESCRIPTIVE STATISTICS

The FIES data set for 1997 covered a total sample of 95 223 households. As already noted, these households had at least two persons. In order to understand Japanese food consumption patterns fully, it is necessary to study the differences among demographic groups. Among the most important demographic variables are age, household size and the number of wage earners. Income is often used as a demographic variable in descriptive analysis. Based on these demographic variables, the distributions of the sample and mean statistics are shown in Annexes A (Table A.1), B (Table B.1) and C (Table C.1).

Annexes A, B and C present descriptive statistics for the daily household consumption of various foods or food groups by income, age, household size and number of wage earners. The descriptive analysis focuses on income–consumption relationships. Tables show the comparisons of average prices paid by households in different demographic groups.

Several important findings can be drawn from these descriptive statistics. As shown in Table A.7, household rice consumption showed a strong positive relationship with income for all age groups, especially for the middle-aged (35 to 44 years) and elderly (more than 65 years) groups. Households in the highest-income group showed some declines in rice consumption. Overall, household daily consumption of rice in 1997 varied from 258.19 g for the lowest-income group to 309.34 g for the highest-income group.

Table A.8 shows per capita rice consumption by age and income. The relationship between per capita rice consumption and income is far less clear than it is for household rice consumption. Except for in the older group, per capita rice consumption tends to fluctuate over the various income levels. This pattern is not unreasonable because many other factors affect per capita rice consumption, for example, household size – as shown in Table B.7. For a household of four members, the per capita consumption of rice steadily increases over income levels, from 66.57 g/day for the lowest-income group to 81.94 g/day for the highest-income group. These descriptive statistics provide clear evidence that rice is not an inferior good in Japan. Furthermore, it should be noted that, even if the descriptive data were to show strong negative relationships between rice consumption and income, it cannot be assumed that rice is an inferior good; for example, per capita beef consumption in the United States declined steadily during the 1980s and 1990s, but no economist claimed that beef was therefore an inferior good in the United States.

Another important finding from the descriptive statistics is that there are strong positive relationships between price and income for many foods in Japan. Table A.16 shows these relationships by age groups. Higher-income households pay higher prices for rice than lower-income households do, and the oldest age group pay higher prices for rice in every income level. It may therefore be reasonable to assume that higher-income and older households tend to buy higher-quality rice than lower-income and younger households. Although the survey did not provide information about the quality of rice purchased by households, it may be possible to investigate the demand for different qualities of rice by estimating the demand function for separate income and/or age groups.

Analysis of the price data for beef shows a very similar pattern of positive relationships between price and income. As shown in Table A.18, higher-income households pay higher prices for beef than lower-income households do. Interestingly, the oldest group also pay far higher prices for beef in every income level. These statistics provide a basis for modelling the demands for different qualities of beef by separating the total sample into income and age subgroups.

HOUSEHOLDS WITH ZERO CONSUMPTION AND MISSING PRICE DATA

One of the major econometric problems in modelling demand using household data is that many households do not purchase various foods during the survey period. Tables 2.2 and 2.3 show the percentages of households with zero consumption.

The problem of missing price data is related to zero consumption. As households with zero consumption provide no information on either expenditures or quantities, no unit values (prices) can be derived for these households. The price used for estimation in this study was obtained by dividing expenditure by quantity purchased. The zero consumption problem poses a serious estimation flaw, as there are no price data for households with zero consumption. In order to obtain price data for these households, it was assumed that each household faces the mean price of each commodity for its respective region, month and income. There are ten regions, five income levels and twelve months, hence a total of 600 average prices for the sample. Households with missing price data are assumed to face the average prices for their income level and region and the month of the survey. FAFH does not have a quantity unit, so the Consumer Price Index (CPI) from the *Annual Report on the Consumer Price Index* (published by the Statistics Bureau of the Management and Coordination Agency) was used for FAFH. The CPI for FAFH has only monthly variations so, within each month, all households have the same CPI for FAFH.

TABLE 2.2
Percentages of households with zero consumption, 11 major commodities

Food variables	%
Non-glutinous rice	43.75%
Bread	4.15%
Noodle	6.14%
Fresh fish and shell fish	2.45%
Fresh meat	1.92%
Milk	8.36%
Eggs	5.51%
Fresh vegetables	0.24%
Fresh fruits	5.50%
Fats and oil	42.12%
FAFH	12.65%

Source: FIES, 1997.

TABLE 2.3
Percentage of households with zero consumption, seven meat products

Food variables	%
Beef	20.63%
Pork	9.50%
Poultry	19.67%
Ground meat	70.37%
Ham	39.29%
Sausage	33.39%
Bacon	59.21%

Source: FIES, 1997.

3. Econometric models for consumption analysis

INTRODUCTION

Application of the theory of the household requires a specific model. In general, econometric studies of demand include both single equations and systems of demand equations. The demand functions can be generalized for a consumer or a household buying n goods as:

$$q_i = q_i (p_1, p_2, \dots p_j, \dots p_n, I), \qquad i = 1, 2, \dots, n. \qquad (3.1)$$

where q_i is the quantity demanded; *p* is the price, the subscript *i* denotes the commodities; and I is income. These "n equations" can be estimated by single equations or by systems of equations. In this study, Equation 3.1 is estimated in a budget share form. Extending the demand function for individual consumers to that for a group of consumers in most empirical applications requires the inclusion of demographic variables besides prices and income. In this section, the econometric models for 11 food items are described. The same methodology also applies to the model for seven meats.

SINGLE EQUATION MODEL

The first empirical model applied in this study is the Working-Leser model. The original form of the Working-Leser model was discussed by Working (1943) and Leser (1963). Intriligator, Bodkin and Hsiao (1996) and Deaton and Muellbauer (1980a) provide a more detailed discussion of this functional form. In the Working-Leser model, each share of the food item is simply a linear function of the log of prices and of the total expenditure on all the food items under consideration. The Working-Leser food demand function can be expressed as:

$$w_i = \alpha_0 + \alpha_i \log x + \sum_j \beta_{ij} \log p_j + \sum_k \gamma_{ik} H_k + \varepsilon_i \qquad (3.2)$$

where (*i*, *j*) represents the 11 food items; w_i is the expenditure share of food *i* among the 11 food items; p_j is the price of food j; and *x* is the total expenditure of all food items included in the model.

H_k includes dummy variables where k is 25:

- *AGE* = log age of household head;
- *SIZE* = log of household size;
- *WE* = number of wage earners;
- *BABY* = number of children aged five years or under;
- *PRIM* = number of children aged between 6 and 12 years;
- *HIGH* = number of children aged between 13 and 18 years;
- *M* = dummy variables for month ($M_1, \dots, M_{10}$);[5]
- *REG* = dummy variables for region ($REG_1, \dots, REG_9$).

ε_i's are random disturbances assumed with zero mean and constant variance. This model can be estimated for each food item by the ordinary least squares (OLS).

[5] Only ten monthly dummies are included in the model because CPI data for FAFH are obtained on a monthly basis.

Demand elasticity formulae for Working-Leser model

It is easy to show the elasticity formulae for the Working-Leser model. The expenditure elasticity (e_i) can be expressed as:

$$e_i = 1 + \left(\frac{\alpha_i}{w_i} \right). \qquad (3.3)$$

Taking a derivative of Equation 3.2 with respect to log(p_j) yields, uncompensated own ($j = i$) and cross ($j \neq i$) price elasticities (e_{ij}) are as follows:

$$e_{ij} = -\delta_{ij} + \left(\frac{\beta_{ij}}{w_i} \right) \qquad \forall i, j = 1, 2, \ldots, n \qquad (3.4)$$

where δ_{ij} is the Kronecker delta that is unity if $i = j$ and zero otherwise. In this study, expenditure, own-price and cross-price elasticities are evaluated at sample means.

Income elasticity in the Working-Leser model

Since the Working-Leser model uses total expenditures for the group of food items included in the model, it does not provide a direct estimate of income elasticity. In order to estimate income elasticity, the following Engel function is estimated:

$$\log x = \alpha_0 + \alpha_1 \log X + \beta \log P + \sum_k \gamma_k H_k + \varepsilon \qquad (3.5)$$

where x is total expenditures of the food included in the model; X is total expenditures of food and non-food consumer goods and services; P is Laspeyres price index for the eleven foods; and other demographic and dummy variables are the same as previously defined. Remaining variables are the same as those in Equation 3.2. Income elasticity can be estimated from Equations 3.2 and 3.5. From Equation 3.2, the expenditure elasticity, $e_i = \frac{\partial q_i}{\partial x}\frac{x}{q_i}$, can be estimated. From Equation 3.5, the responsiveness of expenditure on food items by income change, $s = \frac{\partial x}{\partial X}\frac{X}{x}$, can be derived. Hence, income elasticity is estimated as follows:

$$e_{i(income)} = e_i s = \left(\frac{\partial q_i}{\partial x}\frac{x}{q_i} \right)\left(\frac{\partial x}{\partial X}\frac{X}{x} \right) = \frac{\partial q_i}{\partial X}\frac{X}{q_i}. \qquad (3.6)$$

TOBIT AND HECKMAN'S TWO-STEP ESTIMATOR

When estimating income elasticities, the use of household-level microdata is a good way of avoiding the aggregation problem. However, the use of household microdata on detailed commodities is comlicated by the econometric problem, which arises when some households have zero consumption of one or more of the items considered. In the FIES, the zero consumption problem is particularly severe for rice, oil and fats and FAFH, among the 11 major food commodities, and for ground meat and bacon, in the seven meats model.

It is known that estimates of coefficients are inconsistent when only observed positive purchase data are used to estimate consumption behaviour by OLS regression. The dependent variables – the budget shares of the food items specified – are zero if a household does not purchase the food item, and positive if it does. Zero shares are censored by an unobservable latent variable. In this report, two different models have been applied to correct zero consumption: Heckman's two-step model and the standard Tobit estimator. The derivation of elasticity measure for each model is shown. Each model is based on different assumptions regarding zero consumption. Zero consumption is observed when no purchase of the particular item was made during the month-long survey period. If zero consumption is assumed to be due to sample selection, Heckman's two-step is the appropriate model. The Tobit model simply captures the corner solutions for utility maximization. The results from the three estimators, including OLS, are compared in the following subsections.

Tobit estimator and demand elasticities

The Tobit estimator and elasticity calculation have been the subject of many studies. Notation follows mainly Amemiya (1985) and Maddala (1983).

The Tobit estimator is defined as follows:

$$\begin{cases} y_i = y^* = s_i\beta + u_i \text{ if } \quad y_i^* > 0 \quad u_i \sim N(0,\sigma^2) \\ y_i = 0 \text{ otherwise} \end{cases} \tag{3.7}$$

where β is a k × 1 vector of unknown parameters; s_i is a k × 1 vector of known variables; u_i are residuals that are independently and normally distributed, with mean zero and a common variance σ^2; and y* is an unobservable latent variable.

McDonald and Moffitt (1980) describe how total change in y can be disaggregated into two parts: the change in y above the threshold, weighted by the probability of being above the threshold; and the change in the probability of being above the threshold, weighted by the expected value of y. Unconditional elasticity describes the elasticity of y from the mean of all observed values for y. Conditional elasticity is the elasticity measure that is conditional on the consumer's choice to purchase a non-zero quantity of the good.

Considering the model given in Equation 3.7 and the non-zero observations y_i, the result is:

$$E[y_i \mid y_i > 0] = s_i\beta + E[u_i \mid u_i > -s_i\beta] = s_i\beta + \sigma\frac{\phi_i}{\Phi_i} \tag{3.8}$$

where ϕ_i and Φ_i are the density function and cumulative distribution function of the standard normal evaluated at $\frac{s_i\beta}{\sigma}$. For notational convenience, z is defined as $z_i \equiv \frac{s_i\beta}{\sigma}$.

The following formula is used to obtain predicted values using all the observations:

$$\begin{aligned} E[y_i] &= P(y_i > 0)E[y_i \mid y_i > 0] + P(y_i = 0)E[y_i \mid y_i = 0] \\ &= \Phi_i(s_i\beta + \sigma\frac{\phi_i}{\Phi_i}) + (1-\Phi_i)0 \\ &= \Phi_i s_i\beta + \sigma\phi_i \end{aligned} \tag{3.9}$$

Unconditional and conditional elasticities for a particular variable, s, in a general form can be obtained as follows:

Unconditional elasticity:

$$e_{i,unconditional} = \frac{\partial E[y_i]}{\partial s}\frac{s}{E[y_i]} \tag{3.10}$$

Conditional elasticity:

$$e_{i,conditional} = \frac{\partial E[y_i \mid y_i > 0]}{\partial s}\frac{s}{E[y_i \mid y_i > 0]} \tag{3.11}$$

The prediction of y_i, given s_i, can be obtained from the different expectation functions: unconditional and conditional expectations. Following Maddala (1983) and McDonald and Moffitt (1980), unconditional expectation can be obtained from the derivative of Equation 3.9 without the subscript *i*, which denotes observation:

$$\frac{\partial E[y]}{\partial s} = \beta\Phi(z) \tag{3.12}$$

From Equation 3.12, the partial derivative can be calculated as:

$$\frac{\partial E\left(y \mid y^* > 0\right)}{\partial s} = \beta\left\{1 - z\frac{\phi(z)}{\Phi(z)} - \left(\frac{\phi(z)}{\Phi(z)}\right)^2\right\} \tag{3.13}$$

(See McDonald and Moffitt [1980] for the detailed derivation.)

From these general formulae for elasticity estimation, the elasticity formulae for the Leser-Working model can be derived. In this study, the Working-Leser Model is denoted as:

$$w_i^* = \alpha_0 + \alpha_i \log X + \sum_j \beta_{ij} \log p_j + \sum_k \gamma_{ik} H_k + \varepsilon_i \qquad i \in 1, 2, \ldots, n \tag{3.14}$$

$$w_i = \begin{cases} w_i^* & if \quad w_i > 0 \\ 0 & if \quad w_i \le 0 \end{cases} \text{ and}$$

$$\varepsilon_i \sim N(0, \sigma^2)$$

where subscript *i* denotes a good in question; *X* denotes total expenditure on 11 commodities; p_i and q_i denote price and quantity for *i*th commodity, respectively; and w_i denotes the budget share of *i*th good, $w_i = \frac{p_i q_i}{X}$.

Expenditure elasticity is obtained in the following way:

$$E[w_i] = \frac{p_i E[q_i]}{X}$$

$$E[q_i] = \frac{E[w_i] X}{p_i}$$

$$\frac{\partial E[q_i]}{\partial X}\frac{X}{E[q_i]} = \frac{E[w_i]}{p_i}\frac{X}{E[q_i]} + \frac{\frac{\partial E[w_i]}{\partial x} X}{p_i}\frac{X}{E[q_i]}$$
$$= 1 + \frac{\frac{\partial E[w_i]}{\partial \log X}}{E[w_i]} \qquad (3.15)$$

Since the numerator of Equation 3.15 is the coefficient of Equation 3.14, this formula can be applied to Equation 3.14 evaluated at the sample mean such that ϕ and Φ are the density function and cumulative density function, respectively, of the standard normal evaluated at z_i. For convenience, Equation 3.14 can be rewritten in the compact form: $w_i = x_i\beta + \varepsilon_i$.

Hence, unconditional expenditure elasticity is:

$$\hat{e}_{i,unconditional} = \frac{\partial E[q_i]}{\partial X}\frac{X}{E[q_i]} = 1 + \frac{\Phi(\hat{z}_i)\hat{\alpha}_i}{\Phi(\hat{z}_i)\overline{x}_i\hat{\beta} + \hat{\sigma}_i\phi(\hat{z}_i)} \qquad (3.16)$$

where the upper bar denotes the sample mean, and $\hat{z}_i = \frac{\overline{x}_i\hat{\beta}}{\sigma}$.

Conditional expenditure elasticity is:

$$\hat{e}_i = \frac{\partial E[q_i \mid q^*_i > 0]}{\partial X}\frac{X}{E[q_i \mid q^*_i > 0]} = 1 + \frac{\hat{\alpha}_i\left(1 - \hat{z}_i\frac{\phi(\hat{z}_i)}{\Phi(\hat{z}_i)} - \left(\frac{\phi(\hat{z}_i)}{\Phi(\hat{z}_i)}\right)^2\right)}{\overline{x}_i\hat{\beta} + \hat{\sigma}_i\frac{\phi(\hat{z}_i)}{\Phi(\hat{z}_i)}} \qquad (3.17)$$

Own-price elasticity becomes:

$$\frac{\partial E[q_i]}{\partial p_i} = \frac{\frac{\partial E[w_i]}{\partial p_i} X - E[w_i] X}{p_i^2}$$

$$\frac{\partial E[q_i]}{\partial p_i}\frac{p_i}{q_i} = \frac{p_i}{q_i}\frac{\frac{\partial E[w_i]}{\partial p_i} X - E[w_i] X}{p_i^2} = -1 + \frac{\frac{\partial E[w_i]}{\partial \log p_i}}{E[w_i]} \qquad (3.18)$$

Unconditional own-price elasticity is:

$$\hat{e}_{ii,unconditional} = -1 + \frac{\Phi(\hat{z}_i)\hat{\beta}_{ii}}{\Phi(\hat{z}_i)\overline{x}_i\hat{\beta} + \hat{\sigma}_i\phi(\hat{z}_i)} \quad (3.19)$$

Conditional own-price elasticity is:

$$\hat{e}_{ii,conditional} = -1 + \frac{\hat{\beta}_{ii}\left(1 - \hat{z}_i\frac{\phi(\hat{z}_i)}{\Phi(\hat{z}_i)} - \left[\frac{\phi(\hat{z}_i)}{\Phi(\hat{z}_i)}\right]^2\right)}{\overline{x}_i\hat{\beta} + \hat{\sigma}_i\frac{\phi(\hat{z}_i)}{\Phi(\hat{z}_i)}} \quad (3.20)$$

In the same format, cross-price elasticity can be obtained as follows:

$$\frac{\partial E[q_i]}{\partial p_j} = \frac{\frac{\partial E[w_i]}{\partial p_j}X}{p_j}$$

$$\frac{\partial E[q_i]}{\partial p_j}\frac{p_j}{q_i} = \frac{p_j}{q_i}\frac{\frac{\partial E[w_i]}{\partial p_j}X}{p_j} = \frac{\frac{\partial E[w_i]}{\partial \log p_i}}{E[w_i]} \quad (3.21)$$

Unconditional cross-price elasticity is:

$$\hat{e}_{ij,unconditional} = \frac{\Phi(\hat{z}_i)\hat{\beta}_{ij}}{\Phi(\hat{z}_i)\overline{x}_i\hat{\beta} + \hat{\sigma}_i\phi(\hat{z}_i)} \quad (3.22)$$

Conditional own-price elasticity is:

$$\hat{e}_{ij,conditional} = \frac{\hat{\beta}_{ij}\left(1 - \hat{z}_i\frac{\phi(\hat{z}_i)}{\Phi(\hat{z}_i)} - \left[\frac{\phi(\hat{z}_i)}{\Phi(\hat{z}_i)}\right]^2\right)}{\overline{x}_i\hat{\beta} + \hat{\sigma}_i\frac{\phi(\hat{z}_i)}{\Phi(\hat{z}_i)}} \quad (3.23)$$

Heckman's two-step (sample selection) estimator

In order to correct for the sample bias problem in rice consumption, Heckman's two-step estimation (Heckit) procedure can be applied, as suggested by Heckman (1978). In the first stage, a probit regression is computed in order to estimate the probability that a given household consumes the food item in question. This regression is used to estimate the inverse Mills ratio (λ) for each household, which is used as an instrument in the second regression. In the second stage, the initial Working-Leser model (Equation 3.2) with the inverse Mills ratio is estimated.

In the first stage, the household's decision is modelled as a dichotomous choice problem:

$$I_i = \alpha_0 + \alpha_i \log x + \sum_j \beta_{ij} \log p_j + \sum_k \gamma_{ik} H_k + \varepsilon_i \tag{3.24}$$

where I_i is one if a household consumes *i*th food item (i.e. $w_i > 0$), and zero otherwise. Other variables have already been defined. From Equation 3.24, the inverse Mills ratio (l) for every household can be computed as:

$$\lambda_i = \frac{\phi_i(P, x, d)}{\Phi_i(P, x, d)} \tag{3.25}$$

where P, x, d are the vector of prices; expenditures and the vector of demographic variables for the household, respectively; f_i is the density probability function; and F_i is the cumulative probability function. For notational convenience, this is set as:

$$\lambda_i = \frac{\phi_i(\Gamma_i \omega)}{\Phi_i(\Gamma_i \omega)} \tag{3.25'}$$

where $ũ_i$ is a vector of regressors explaining the binary choice in the first stage; and ω is the conformable parameter vector.

In the second step, the following Working-Leser demand function incorporating the computed inverse Mills ratio, λ_i, as an instrument variable is estimated:

$$w_i = \alpha_0 + \alpha_i \log x + \sum_j \beta_{ij} \log p_j + \sum_k \gamma_{ik} H_k + \theta_i \lambda_i + \varepsilon_i \tag{3.26}$$

where d_i is the parameter associated with the inverse Mills ratio. It is important that only the non-zero observations on w_i are used in the second-stage estimation in order to estimate the conditional elasticity.[6] The whole sample is used to estimate the unconditional elasticity.

It is important to note that at least one of the explanatory variables in the first equation is not included at the second step for identification, according to Maddala (1983) Amemiya (1985) and Johnston and DiNardo (1997). The city size dummy variables based on the population are added in the first step: cities are divided into major cities (population of at least 1 million), middle-sized cities (population of 150 000 to 1 million), small cities A (population of 50 000 to 150 000) and small cities B (population of fewer than 50 000).

Demand elasticities for Heckman's two-step estimator

Even though Heckman's two-step estimator is fairly common in empirical studies, there is little literature on its elasticity estimation. Byrne, Capps and Saha (1996) explicitly show elasticity estimates of Heckman's two-step estimator for a single equation case. Later, Saha, Capps and Byrne (1997) generalized the method from a single equation to a system of equations. For this report, the methodology developed by Byrne, Capps and Saha (1996) and Saha, Capps and Byrne (1997) was adapted and applied to the Working-Leser model.

At the first stage, the inverse Mills ratio is estimated by the dichotomous-choice probit model. In a general form, the estimated inverse Mills ratio, $\hat{\lambda}_i$, is described in Equation 3.25. In the second stage

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[6] When a system of equations with inverse Mills ratio is used, the convention is to use the whole sample.

equation, the conditional expectation of the dependent variable can be calculated in a general form as follows:

$$E\left[Y_i \mid Y_i > 0\right] = x_i\beta + \varphi_i\,\hat{\lambda}_i \text{ and } \hat{\lambda}_i = \frac{\phi_i(\Gamma_i\omega)}{\Phi_i(\Gamma_i\omega)} \quad (3.27)$$

where x_i is the vector of regressors explaining the magnitude of Y_i in the second stage equation; β is the associated parameter vector; and φ_i is a parameter corresponding to the estimated inverse Mills ratio, which is estimated at the first stage. In order to derive conditional elasticity, only the non-zero observation of Y_i is used for the second stage of Heckman's two-step estimator.

Taking a partial derivative with respect to x_i (x_i may be considered as any variable in the vector of regressors):

$$\frac{\partial E\left[Y_i \mid Y_i > 0\right]}{\partial x_i} = \beta + \varphi_i\,\frac{\partial \hat{\lambda}_i}{\partial x_i} \quad (3.28)$$

According to Saha, Cappas and Byrne (1997), this can be simplified as:

$$\frac{\partial E\left[Y_i \mid Y_i > 0\right]}{\partial x_i} = \beta - \varphi_i\,\omega_i\left\{\Gamma_i\omega\hat{\lambda}_i + \hat{\lambda}_i^{\,2}\right\} \quad (3.29)$$

where β and φ_i are parameters corresponding to x_i and the inverse Mills ratio at the second stage equation, respectively; ω_i is a parameter associated with x_i at the first stage; Γ_i is the vector of regressors explaining the binary choice in the first stage; and ω is the comfortable parameter vector, as already defined. Marginal effects are evaluated at the sample mean. The average of the inverse Mills ratio can be estimated by adding up the results of all the observations and dividing by the number of observations.

In order to estimate unconditional elasticity, the whole sample needs to be used for the second stage so that zero-consumption households are taken into account. In the second stage estimation, the expectation of the dependent variables becomes as follows:

$$E\left[Y_i \mid Y_i > 0\right] = x_i\beta + \varphi_i\,\frac{\phi_i(\Gamma_i\omega)}{\Phi_i(\Gamma_i\omega)} \quad (3.30)$$

$$E\left[Y_i \mid Y_i = 0\right] = x_i\beta + \varphi_i\,\frac{\phi_i(\Gamma_i\omega)}{1-\Phi_i(\Gamma_i\omega)} \quad (3.31)$$

A partial derivative with respect to x_i can be taken to produce the following:

$$\frac{\partial E\left[Y_i \mid Y_i > 0\right]}{\partial x_i} = \beta - \varphi_i\,\omega_i\left\{\Gamma_i\omega\frac{\phi_i(\Gamma_i\omega)}{\Phi_i(\Gamma_i\omega)} + \left(\frac{\phi_i(\Gamma_i\omega)}{\Phi_i(\Gamma_i\omega)}\right)^2\right\} \quad (3.32)$$

$$\frac{\partial E\left[Y_i \mid Y_i = 0\right]}{\partial x_i} = \beta - \varphi_i\, \omega_i \left[\Gamma_i \omega \frac{\phi_i(\Gamma_i \omega)}{1-\Phi_i(\Gamma_i \omega)} + \left(\frac{\phi_i(\Gamma_i \omega)}{1-\Phi_i(\Gamma_i \omega)} \right)^2 \right] \qquad (3.33)$$

Denoting θ as the proportion of observations for which $Y_i > 0$, hence $0 < \theta < 1$, Saha. Capps and Byrne (1997) suggest taking a weighted average of these two biases, as follows:

$$\frac{\partial E\left[Y_i\right]}{\partial x_i} = \beta - \varphi_i\, \omega_i \left(\theta \left[\Gamma_i \omega \frac{\phi_i(\Gamma_i \omega)}{\Phi_i(\Gamma_i \omega)} + \left(\frac{\phi_i(\Gamma_i \omega)}{\Phi_i(\Gamma_i \omega)} \right)^2 \right] + \left(1-\theta\right) \left[\Gamma_i \omega \frac{\phi_i(\Gamma_i \omega)}{1-\Phi_i(\Gamma_i \omega)} + \left(\frac{\phi_i(\Gamma_i \omega)}{1-\Phi_i(\Gamma_i \omega)} \right)^2 \right] \right) \qquad (3.34)$$

The sample mean for the bias term is calculated as before: the bias terms of each observation are added together and the result is divided by the number of observations.

In order to apply these computations for the Working-Leser model, the marginal value needs to be adjusted to follow the elasticity formula. It then becomes possible to calculate the elasticities for conditional price, conditional expenditure, unconditional price and unconditional expenditure, as follows:

$$e_i \,\Big|_{\substack{\text{conditional}\\ \text{expenditure}\\ \text{elasticity}}} = 1 + \left(\frac{\dfrac{\partial E\left[Y_i \mid Y_i > 0\right]}{\partial\, x} \Big|_{\text{at sample mean}}}{\overline{w}_i} \right) \qquad (3.35)$$

$$e_{ij} \,\Big|_{\substack{\text{conditional}\\ \text{price}\\ \text{elasticity}}} = -\delta_{ij} + \left(\frac{\dfrac{\partial E\left[Y_i \mid Y_i > 0\right]}{\partial p_j} \Big|_{\text{at sample mean}}}{\overline{w}_i} \right) \qquad (3.36)$$

$$e_i \,\Big|_{\substack{\text{unconditional}\\ \text{expenditure}\\ \text{elasticity}}} = 1 + \left(\frac{\dfrac{\partial E\left[Y_i\right]}{\partial\, x} \Big|_{\text{at sample mean}}}{\overline{w}_i} \right) \qquad (3.37)$$

$$e_{ij} \,\Big|_{\substack{\text{unconditional}\\ \text{price}\\ \text{elasticity}}} = -\delta_{ij} + \left(\frac{\dfrac{\partial E\left[Y_i\right]}{\partial p_j} \Big|_{\text{at sample mean}}}{\overline{w}_i} \right) \qquad (3.38)$$

A COMPLETE DEMAND SYSTEM

Deaton and Muellbauer (1980a; 1980b) developed a flexible demand system called the "almost ideal demand system" (AIDS). The concept of a flexible demand system is extremely useful for estimating a demand system with many desirable properties. As Moschini (1998) pointed out, the AIDS model automatically satisfies the aggregation restriction, and with simple parametric restrictions, homogeneity and symmetry can be imposed. In addition, the non-linear Engel curves of the AIDS model imply that an increase in income will lead to a decrease in the share of income allocated to a particular commodity, as well as a decrease in the income elasticity of that good when it is less than one. However, the AIDS model may be difficult to estimate because the price index is not linear in terms of parameters estimated. Owing to its simplicity, the linear approximate almost ideal demand system (LA/AIDS) is popular for empirical studies. Both the LA/AIDS and the AIDS models were applied for this report.

The AIDS model for the 11 food commodities can be estimated as follows:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \ln(p_j) + \beta_i \ln(\frac{x}{P}) + \mu_i \qquad i = 1, \ldots, 11 \qquad (3.41)$$

where w_i is the budget share of good i; p_j is the price of good j; x is the total expenditure of the goods in question; μ_i is the random disturbances assumed with zero mean and constant variance; and P is a translog price index defined by:

$$\log P = \alpha_0 + \sum_k \alpha_k \ln p_k + \frac{1}{2} \sum_k \sum_l \gamma^*_{kl} \ln p_k \ln p_l \qquad (3.42)$$

Where k is = 1, …, 11; l is 1, …, 11; and the γij parameters are defined under symmetry as follows:

$$\gamma_{ij} = \frac{1}{2}(\gamma^*_{ij} + \gamma^*_{ji}) = \gamma_{ji} \qquad j = 1, \ldots, 11 \qquad (3.43)$$

The model defined by Equations 3.41 to 3.43 is called the AIDS model.

It is easy to check that the adding-up restriction is satisfied with the given $\sum_i w_i = 1$ for all j:

$$\sum_i \alpha_i = 1, \sum_i \beta_i = 0, \text{ and } \sum_k \gamma_{kj} = 0 \qquad (3.44)$$

The homogeneity restriction is satisfied for the AIDS model if, and only if, for all j:

$$\sum_k \gamma_{jk} = 0 \qquad (3.45)$$

The symmetry is satisfied by:

$$\gamma_{ij} = \gamma_{ji} \qquad (3.46)$$

Using the price index in Equation 3.42 raises estimation difficulties caused by the non-linearity of parameters. In addition, the theory of the household does not provide any empirically plausible value for α_0.

As Asche and Wessells (1997) point out, the Stone index is widely used for LA/AIDS estimation:

$$\ln(P^*) = \sum_i w_i \ln(p_i) \qquad i = 1, \ldots, 11 \qquad (3.47)$$

where w is budget share among the 11 commodities. The Stone index is an approximation proportional to the translog, i.e. P = φ P* where E(ln(φ)) = α_0. The LA/AIDS model with the Stone index can be denoted as follows:

$$w_i = \alpha_i^* + \sum_j \gamma_{ij} \ln(p_j) + \beta_i \ln(\frac{x}{P^*}) + \mu_i^* \qquad (3.48)$$

where $\alpha_i^* = \alpha_i - \beta_i \alpha_i$ and $\mu_i^* = \mu_i - \beta_i (\ln(\varphi) - E(\ln(\varphi)))$.

Since prices will never be perfectly collinear, it is widely cited that applying the Stone index will introduce the units of measurement error (see Alston, Foster and Green, 1994; Asche and Wessells, 1997; Moschini, 1995). The Stone index does not satisfy the fundamental property of index numbers because it is variant to changes in the units of measurement for prices. One of the solutions to correct the units of measurement error is that prices are scaled by their sample mean. Following Moschini's suggestion (1995), a Laspeyres price index can be used to overcome the measurement error. Specifically, the log-linear analogue of the Laspeyres price index is obtained by replacing w_i in Equation 3.47 with $\bar{w}_i$, which is a mean budget share. Hence, the Laspeyres price index becomes a geometrically weighted average of prices:

$$\ln(P^L) = \sum_i \bar{w}_i \ln(P_i) \qquad (3.49)$$

Substitution of Equation 3.49 into Equation 3.48 yields a LA/AIDS model with the Laspeyres price index as follows:

$$w_i = \alpha_i^{**} + \sum_j \gamma_{ij} \ln(p_j) + \beta_i (\ln(x) - \sum_j \bar{w}_j \ln(p_j)) + \mu_i^{**} \qquad (3.50)$$

where $\alpha_i^{**} = \alpha_i - \beta_i (\alpha_0 - \sum_j \bar{w}_j \ln(\bar{p}_j))$.

Following Pollak and Wales (1978; 1981), linear demographic translating is applied, $D^i(\eta) = \sum_{r=1}^{N} \delta_{ir} \eta_r$, where δ and η are associated parameters and demographic variables, respectively. In this study, linear demographic translating replaces Equation 3.41 as follows:

$$w_i = \alpha_i^{***} + \sum_k \delta_{ik} \eta_k + \sum_j \gamma_{ij} \ln(p_j) + \beta_i (\ln(x) - \sum_j \bar{w}_j \ln(p_j)) + \mu_i^{***} \qquad (3.51)$$

where $\alpha_i^{***} = \alpha_i^{**} - \sum_k \delta_{ik} \eta_k$. The demographic and dummy variables used in the complete demand system are the same as the ones used in single equation models.

The adding-up restriction requires:

$$\sum_i \alpha^{***} = 1, \text{ and } \sum_i \delta_{ik} = 0, \qquad k = 1, \ldots, m \qquad (3.52)$$

where m is the number of demographic and other dummy variables.

In order to correct for the zero consumption problem, the generalized Amemiya's two-stage estimators are applied to a simultaneous-equation model (see Amemiya, 1974; Lee and Pitt, 1986; and Heien and Wessells, 1990). In the first stage, the probit model with dichotomous choices is estimated. The inverse Mills ratio is derived from the regression results. For the LA/AIDS model, the inverse Mills ratios of only rice, fats and oil and FAFH are used. These three inverse Mills ratios are used as instruments in the second stage. Similar arguments are adopted from the Heckman's two-step estimator, as already discussed.

DEMAND ELASTICITIES FOR THE AIDS MODEL

The elasticity derivations for the AIDS and LA/AIDS models are widely investigated and well documented. Following Buse (1994) and Green and Alston (1990), taking the derivative of Equation 3.48 with respect to ln(x), the expenditure elasticity e_i can be obtained as follows:

$$e_i = 1 + \left(\frac{1}{w_i}\right)\left(\frac{\partial w_i}{\partial \ln(x)}\right) = 1 + \left(\frac{\beta_i}{w_i}\right) \qquad (3.53)$$

Taking the derivative with respect to $ln(p_j)$, uncompensated own- ($j = i$) and cross- ($j \neq i$) price elasticities, $e_{ij}^{LA/AIDS}$, become as follows:

$$\begin{aligned} e_{ij}^{LA/AIDS} &= -\delta_{ij} + \left(\frac{1}{w_i}\right)\left(\frac{\partial w_i}{\partial \ln\left(p_j\right)}\right) \\ &= -\delta_{ij} + \left(\frac{\gamma_{ij}}{\bar{w}_i}\right) - \left(\frac{\beta_i}{\bar{w}_i}\right)\bar{w}_j \qquad \forall i, j = 1, 2, \ldots, n, \end{aligned} \qquad (3.54)$$

where δ_{ij} is the Kronecker delta that is unity if $i = j$, and zero otherwise. In this study, the sample mean is used for the point of normalization.

The Hicksian compensated price elasticities can be derived for the AIDS and LA/AIDS models. The compensated price elasticities, $s_{ij}^{LA/AIDS}$, at the point of normalization become as follows:

$$\begin{aligned} s_{ij}^{LA/AIDS} &= e_{ij} + e_i w_j \\ &= -\delta_{ij} + \left(\frac{\gamma_{ij}}{\bar{w}_j}\right) + \bar{w}_j \qquad \forall i, j = 1, 2, \ldots, n. \end{aligned} \qquad (3.55)$$

For the AIDS model, following Buse (1994), Equation 3.53 is applied for expenditure elasticity. Following Green and Alston (1990), uncompensated own- and cross-price elasticities, e_{ij}^{AIDS} , become as follows:

$$e_{ij}^{AIDS} = -\delta_{ij} + \frac{\gamma_{ij}}{\overline{w}_i} - \frac{\beta_i}{\overline{w}_i}\left(\alpha_j + \sum_{k=1}^{n} \gamma_{kj} \ln \overline{P}_k\right). \qquad (3.56)$$

Compensated own- and cross-price elasticities, s_{ij}^{AIDS} , become as follows:

$$s_{ij}^{AIDS} = -\delta_{ij} + \frac{\gamma_{ij}}{\overline{w}_i} + \overline{w}_j - \frac{\beta_i}{\overline{w}_i}\left(\alpha_j + \sum_{k=1}^{n} \gamma_{kj} \ln \overline{P}_k - \overline{w}_j\right). \qquad (3.57)$$

4. Rice demand analysis

INTRODUCTION

The 1994 Marrakech Agreement of the General Agreement on Tariff and Trade (GATT) Uruguay Round started a process of agricultural market liberalization. The new round of World Trade Organization (WTO) negotiations, launched in 2000, is expected to bring this process further. The world rice market is a thin one; 90 percent of production and consumption occur in Asia. The GATT/WTO decisions will design a new structure for world agricultural markets, and it is important to understand how this will influence the rice market in the near future.

Japan reached a high level of economic growth earlier than other Asian nations. Recently, the Newly Industrialized Economies (NIEs) of the Republic of Korea, Taiwan Province of China and Singapore have been catching up rapidly and attaining higher per capita incomes. Many Asian nations may eventually reach the economic levels of Japan, Europe and the United States. Japanese consumption behaviour is a key indicator for forecasting the future consumption patterns of Asian nations. For example, the Republic of Korea accepted the same minimum access import requirements in the GATT negotiations as Japan did, and the agriculture sector of Taiwan Province of China is very similar to that of Japan. By investigating Japanese consumption behaviour as representative of high-income consumers, this report will shed some light on the future direction of Asian and world rice demand.

In addition to a general concern about Japanese consumption behaviour, it is also of great interest to ascertain whether rice is a normal or an inferior good, i.e. whether per capita rice consumption goes up or down as income increases. Since rice is a very important food staple in Asian countries, many domestic and international agricultural trade policies are centred on it. Such important agricultural policies would be misdirected if they were based on a belief that rice is an inferior good, without a rigorous and robust estimation of that characteristic.

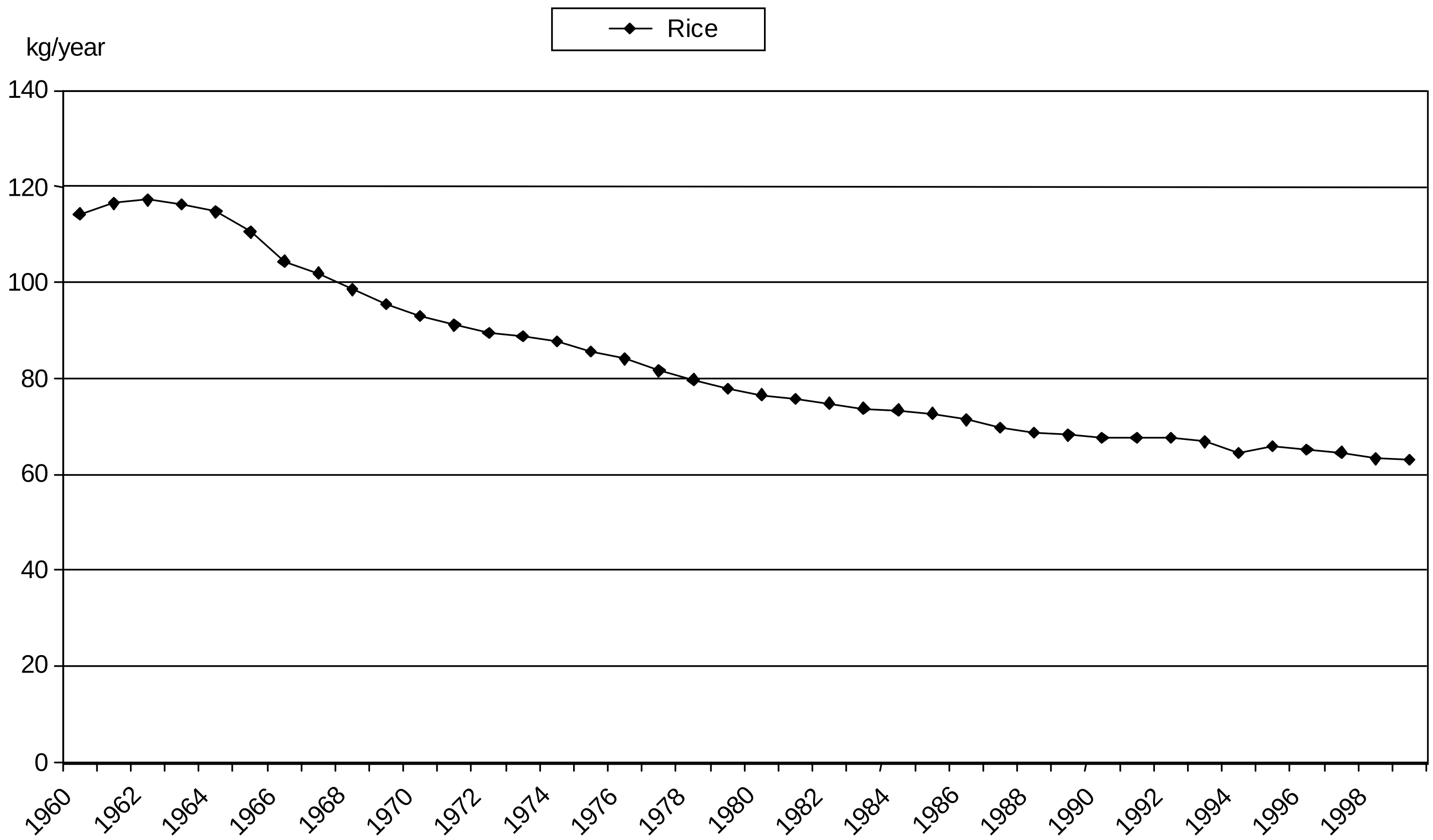
When assessing food balances, the literature on the rice market is mainly concerned with supply-side factors (Oniki, 1996; Fujiki, 1993; 1998; 1999). Considering the uncertain environment of the rice market in the future, the demand side should not be neglected. In order to obtain an accurate forecast of the impact of liberalization of the Japanese rice market, it is necessary to estimate demand elasticities precisely.

BACKGROUND

Japan reached high per capita income far earlier than other Asian nations did. As per capita income grows, food consumption patterns change. Many studies report on the Westernization of the Japanese diet: less calorie intake comes from rice and more from animal meat, and the fat content of food has increased. Because of geographical reasons and preferences, in a typical Japanese diet the calorie intake from fish has a larger share than that from meat.

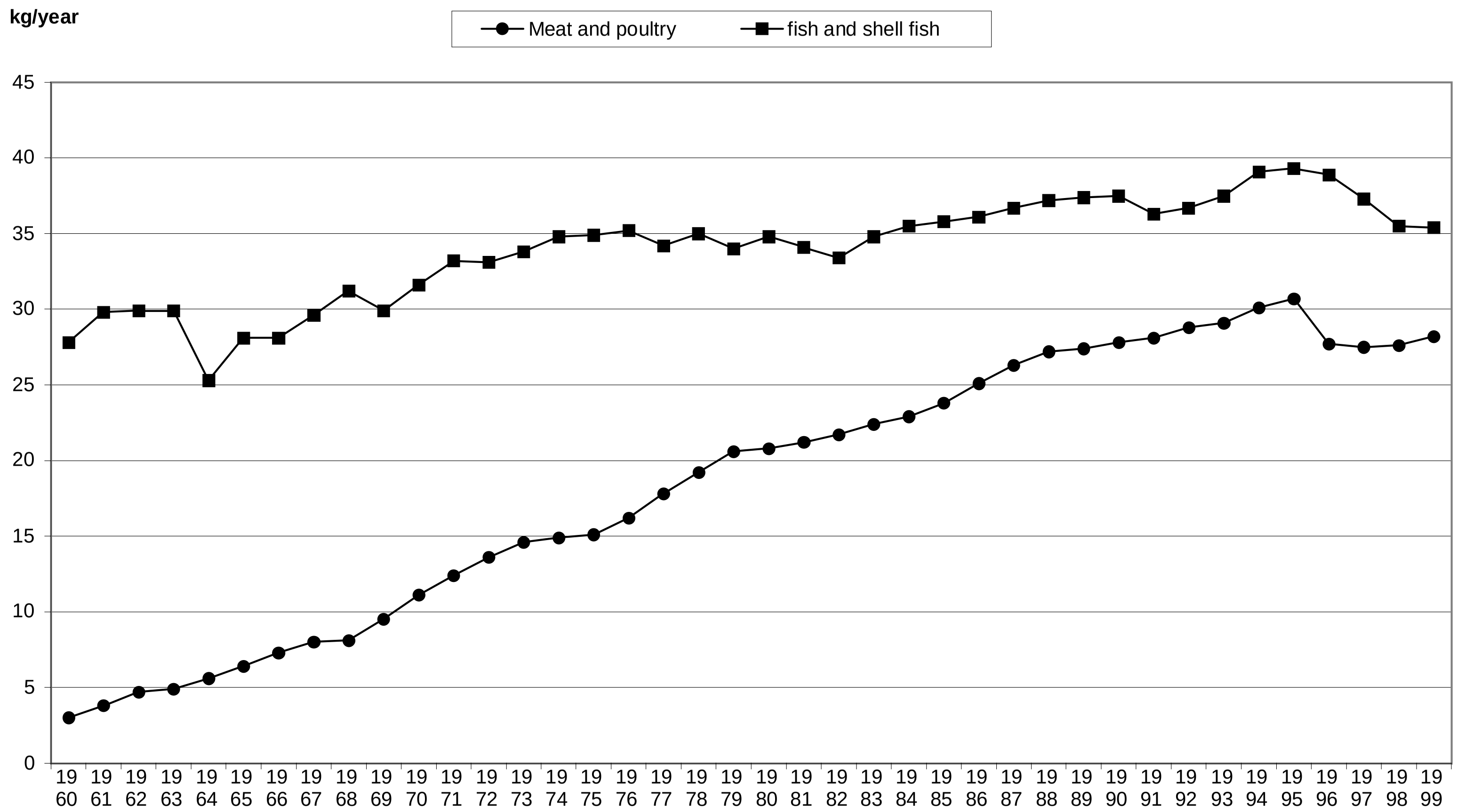
This chapter gives an overview of the time trend of rice consumption patterns. Figures 4.1 to 4.3 show descriptive consumption patterns in Japan. All data are taken from the *Food Balance Sheet* published

Figure 4.1: Annual per capita rice consumption, 1960–1999



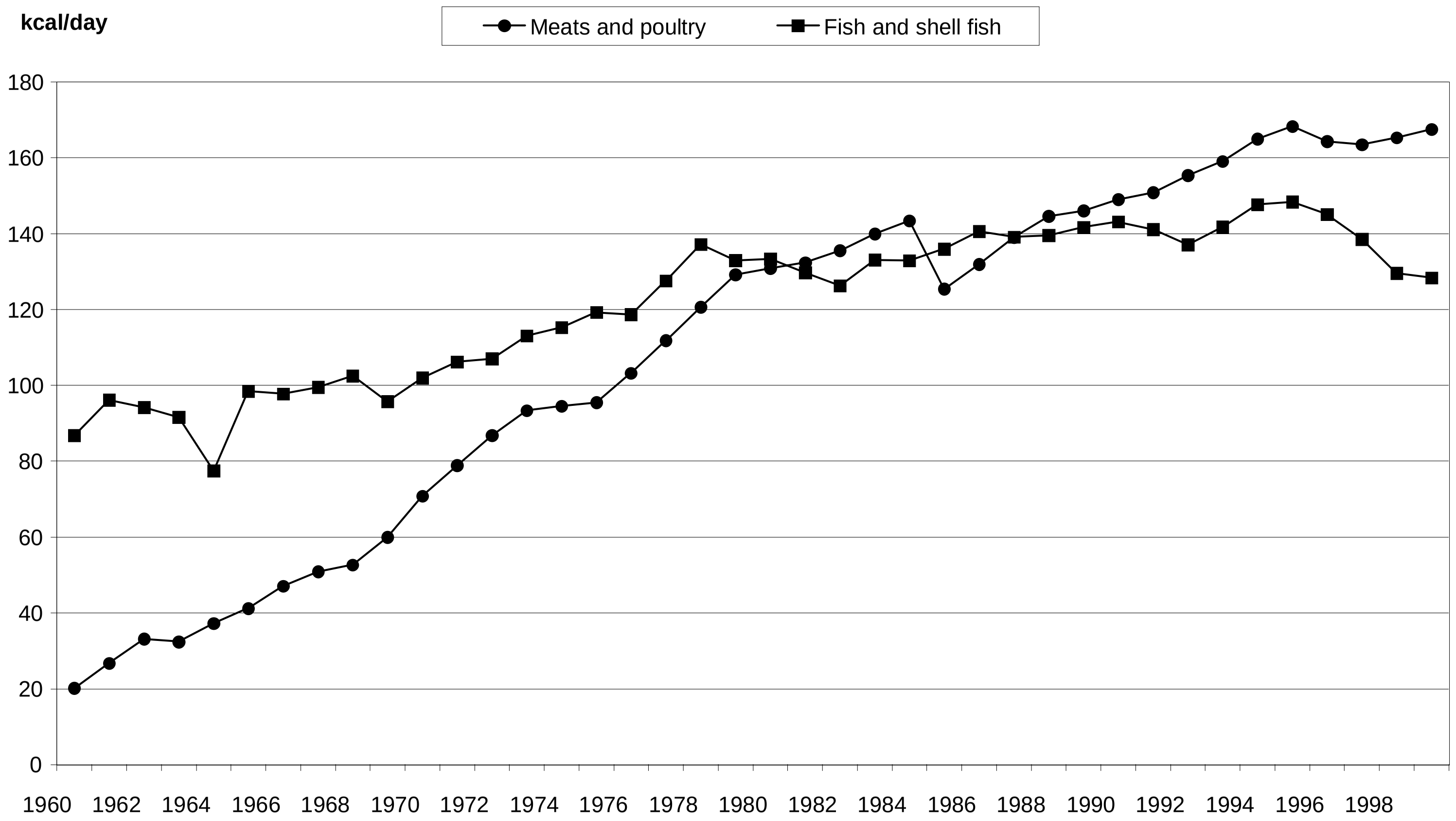
Source: MAFF, 2001.

Figure 4.2: Annual per capita meat, poultry and fish consumption, 1960–1999



Source: MAFF, 2001.

Figure 4.3: Average daily per capita calorie intake, 1960–1999



Source: MAFF, 2001

by Japan's Ministry of Agriculture, Forestry, and Fisheries (MAFF, 1997). These are supply-side data: data on the quantities of food items delivered to consumers are added together.[7]

Figure 4.1 shows the annual per capita rice consumption of Japan. It is well known that aggregate rice consumption in Japan has been declining over recent decades, as is common among high-income countries. Per capita rice consumption peaked in 1962 and had almost halved by the end of the 1990s. Figure 4.2 shows annual per capita meat (beef and pork), poultry and fish consumption. By weight, Japanese households consume more fish than meat and poultry, and this is one of the unique features of the Japanese food consumption pattern. Figure 4.3 shows the average daily per capita calorie intake from meat, poultry and fish and shellfish. Since 1980, meat and poultry have become a larger source of calories than fish. Although Japanese fish consumption by weight is higher than that of meat and poultry, in nutrition terms, meat and poultry provide a higher calorie intake than fish does.

Two considerations should be noted from these figures. First, they provide little information about the price and income elasticities of each commodity. Calorie intake is purely a behavioural variable, and it does not reveal any clear price information; many authors cite a multitude of reasons why calorie elasticity and price and income elasticity are different (Deaton, 1997). Second, the food balance sheet provides macrodata, which may not capture individual household consumption patterns accurately. That is, there may be an aggregation problem. For estimating income elasticities, household survey data should provide a better picture of individual household consumption patterns.

In this report, the income elasticity has been estimated from cross-sectional survey data to shed some light on important issues. Two important questions regarding Japanese rice consumption are investigated: whether rice is an inferior good in Japan; and whether rice is a complement or a substitute for meat, fish and other food items.

Is rice an inferior good in Japan?

Rice is a staple food in Japan, and its great importance in the Japanese diet is well known. In 1995, 10 748 000 tonnes of rice were produced domestically, and 10 485 000 tonnes were consumed. Rice is used by a variety of sectors, but mostly by the household. According to the Management and Coordination Agency (1999), in 1995, 93.21 percent of rough rice was purchased by the milling sector and 74.38 percent of milled rice was consumed directly by households (see Table 4.1).

It is important to understand whether rice is a normal or an inferior good. Japan has one of the highest per capita gross domestic products (GDPs) in the world. If rice were an inferior good, rice consumption would fall as per capita GDP grows. If that were the case, and if Japan were considered as the leading case for other Asian countries, it would be possible to project lower world rice demand in the future as the incomes of Asian nations increase.

Among researchers it has been accepted that income elasticities for rice and other food staples decline as per capita income increases. Researchers believe that in such developed countries as Japan rice became an inferior good several decades ago.

However, there is conflicting evidence regarding whether rice is an inferior good. One of the most influential studies on rice consumption in Asia is an empirical study conducted by Ito, Peterson and Grant (1989). Utilizing aggregate national-level data, the authors concluded that rice was an inferior good in high-income Asian countries. They estimated the income elasticity of rice in Japan to be -0.091 in 1964 and -0.708 in 1984. Kako, Gemma and Ito (1997) projected Japanese rice demand by applying a log-linear function estimated by OLS using time series data for the period 1970 to 1991. These authors supported their colleagues' results; they found evidence that rice was an inferior good

[7] It should be noted that these data are different from household survey data, which are utilized in econometric analysis in this report.
[9] On the other hand, there are virtually no beef exports.

TABLE 4.1
Industry output

Purchased sector	Rice output	
	Value *(yen)*	**Percentage share**
Output of rough rice		
Milling	3 232 103	93.21
Rice wine	195 609	5.64
Rough rice	28 612	0.83
Agricultural services	6 690	0.19
Livestock	3 869	0.11
Other foodstuffs	727	0.02
Total	**3 467 610**	
Ouput of milled rice		
Household consumption	2 604 991	74.38
Restaurants and hotels	553 485	15.80
School and hospital lunches	113 625	3.39
Rice powder and snacks	94 771	2.71
Alchoholic beverages	67 076	1.92
Prepared instant food	63 038	1.80
Other (non-food) uses	499	0.01
Total	**3 502 485**	

Source: Management and Coordination Agency, 1999.

and that meat products were substitutes for rice. Estimated own-price elasticity was -0.130, and expenditure elasticity was -0.308. In a recent study, Price and Gislason (2001) investigated the habit formation of Japanese consumption, utilizing time series survey data from 1963 to 1991. The authors found that the expenditure elasticity of cereal was -0.01 in the short term and -0.015 in the long term. This result indicates that cereal, including all kinds of rice and noodles, is indeed an inferior good.

Sawada (1980) studied the Japanese food demand system using the Rotterdam model. Monthly survey data covered the period from 1956 to 1975. Food item categories included cereal, fish, meat, eggs, vegetables, fruits, FAFH, other food and non-food items. The expenditure elasticity for rice (-0.395) was negative, and rice was the only item to show a negative expenditure elasticity. The own-price elasticities for rice, fish, meat and FAFH were -0.17, -0.545, -0.799 and -0.353, respectively. Utilizing monthly time series survey data from 1964 to 1979, Sawada (1983) estimated Japanese price and expenditure elasticities with the AIDS model. Results indicated that the own-price elasticities for staple food, fish, meat and FAFH were -0.903, -1.125, -0.981 and -1.522, respectively. The own-price elasticity for staple food was particularly high, and was similar to that of meat. In another study, Sawada (1984) used a two-level food demand system to estimate own-price and cross-price elasticities for 17 products in Japan. Data were taken from the FIES and were monthly time series from 1963 to 1981. The own-price elasticity for rice was -0.26, and its expenditure elasticity was -0.73. It is noteworthy that, among the 17 products, rice was the only one to show a negative expenditure elasticity. The results indicated that the magnitude of price elasticity was similar to that of expenditure elasticity in absolute terms, i.e. if a good is price-elastic, it tends to be expenditure-elastic as well. It is interesting to note that the expenditure elasticity for beef (1.93) was the highest among the 17 goods, and the expenditure elasticity for FAFH was the second highest (1.82). Sawada (1986) later estimated the income elasticities of cereal and related goods using survey data from 1976 to 1984 by means of the generalized Houthakker's method. The author concluded that demand was largely influenced by income, the number of household members and the age of the household head. Price elasticities for food were small compared with income elasticities, and this tendency was particularly strong with respect to the number of household members.

Bouis (1991) objected to the Ito, Peterson and Grant study (1989) and claimed that time series estimates of grain consumption have a downward bias owing to the urban–rural migration pattern and the decreasing importance of rice production. From their estimated calorie–income elasticities, Bouis and Haddad (1992) and Bouis (1994) claimed that cross-sectional data estimates of income elasticity are upwardly biased owing to leakage from actual consumption, such as meals for guests and animal feeding in developing countries. As Chern (2000) and Huang and Bouis (1986) pointed out, plotting aggregate consumption against per capita income simply showed the correlation between the two variables, and did not necessarily reveal the true consumption behaviour. Accurate incomeelasticitycan be obtained from cross-sectional data and, in this report, income elasticities among various income classes have been estimated.

Is rice a complement or a substitute for meat, fish and other food items?

Many time series studies show that people consume more meat and poultry as their per capita income increases. Japan is no exception: the consumption of meat and poultry has been increasing, while that of rice has decreased since the 1960s. At the same time, consumers have started to have more varied diets. Regarding the history of calorie intake in Japan, Morishima, Aita and Nakagawa (1993) provide a succinct historical view from the early 1920s. The authors compare the budget shares of 12 food items in 1970, 1980 and 1989. The budget share of grains decreased (from 16.9 percent in 1970 to 12.1 percent in 1989), while that of FAFH increased substantially (from 9.3 percent in 1970 to 15.6 percent in 1989). This observation indicates that consumption patterns are shifting from starchy food to non-starchy food and from consumption at home to FAFH.

Tokoyama and Egaitsu (1994) investigated trends in Japanese food consumption patterns in the period 1963 to 1991. They classified per capita consumption patterns in various ways to show the trends of goods. They concluded that saturation and stability characterize Japanese dietary patterns: the demand trends of foods have been stable for a while. Recently, a preference for higher-quality food has been replaced by diversification and health concerns in food consumption. In addition, as a result of the increased opportunity cost of labour for household work, the demand for convenient food has risen.

As these studies show, the variety and nature of Japanese dietary patterns have shifted substantially over the years, and it is important to understand the demand relationship of rice among other major food items. This report estimates demand relationships among rice, meats, poultry, fish and other products in order to investigate the substitution and complementary patterns.

CROSS-SECTIONAL ANALYSIS

One of main objectives of this report is to analyse food consumption patterns, as well as to conduct an econometric analysis of the food demand structure in Japan. Cross-sectional household data from the 1997 FIES are used. The FIES provides household data on a monthly basis. Participants are asked to keep a Household Schedule, a Family Account Book and a Yearly Income Schedule. They join the survey for six months, and every month one-sixth of participating households are replaced by new ones.

Estimations are based on a total of 95 223 observations. The food items surveyed are non-glutinous rice, bread, noodles, fresh fish and shellfish, fresh meat, milk, eggs, fresh vegetables, fresh fruits, fats and oil, and FAFH. The present report is unusual in that the income elasticities of rice and other related foods are estimated with large degrees of freedom. Such a cross-sectional study of Japanese consumption patterns is virtually unique, and the authors have no knowledge of other instances in which survey data have been used to estimate a food demand system. The results produced for this report are therefore of great potential interest to demand analysts and policy-makers. In order to incorporate household-level microdata, the authors applied the following single equation models: the Working-Leser model estimated by OLS; Heckman’s sample selection model; and the Tobit model. Most coefficients have correct signs and are statistically significant. For a complete demand system analysis, the linearly approximated almost ideal demand system (LA/AIDS) and the almost ideal demand system (AIDS) were applied. The concept of a flexible complete demand system yields consumption behaviour estimates that have many desirable properties: the aggregation, homogeneity and symmetry conditions can be tested, as was rarely the case for previous demand studies on this topic. The LA/AIDS poses a unit of measurement problem. In order to obtain more accurate estimations, LA/AIDS models with two price indices were compared: the Stone price index and the Laspeyres price index. In order to correct a censored dependent variable problem, a censored regression approach was used, as mentioned in Chapter 3.

Empirical results

To investigate the differences in demand structure among income groups, the original sample of 95 223 households was divided according to annual income levels (see Table 4.2).

TABLE 4.2
Classification of households by income level

Income class	Annual income level	
	In Japanese yen	In US dollars
Class 1	Less than ¥4 020 000	Less than $31 904
Class 2	¥4 020 000 to ¥5 680 000	$31 904 to $45 079
Class 3	¥5 680 000 to ¥7 450 000	$45 079 to $59 217
Class 4	¥7 450 000 to ¥9 900 000	$59 217 to $78 571
Class 5	¥9 900 000 and more	$78 571 and more

Note: The exchange rate of US$1 = 126 Yen (as of 23 July 2001) is used.
Source: FIES, 1997.

When the Working-Leser model is estimated with the price data described in the previous paragraph, zero consumption households with a zero budget share are assumed to face the mean prices for the particular geographic location, month and income level concerned. In the censored regression, data are corrected by Heckman's two-step procedure. Econometric models and estimation models are described in Chapter 3. In addition to the usual expenditure and price variables, many demographic variables are also considered. Specifically, these include age of household head, household size, number of wage earners, and numbers of children aged five years or less, between six and twelve years, and between 13 and 18 years.

The estimates of expenditure and income elasticities from the whole sample working Leser model (OLS) are shown in Table 4.3. The results indicate that rice is not an inferior good according to this estimation. The expenditure elasticity of rice exceeds one. Other commodities are relatively expenditure-inelastic, with the exception of FAFH, which has the highest expenditure elasticity. It is noteworthy that the own-price elasticity for rice is very elastic. This indicates that Japanese consumers are sensitive to price changes in rice. If this estimate represents Japanese consumer behaviour correctly, rice imports – which should lead to a reduction in price – might benefit not only consumers but also rice farmers. The high expenditure and own-price elasticities for rice seem to be problematic and their credibility needs further validation.

Table 4.4 shows expenditure elasticities by income bracket. Most estimates are relatively invariant with income level. Fresh fish and meat show that lower-income consumer demand tends to be more expenditure-elastic, while higher-income consumers are less elastic. Table 4.5 shows own-price elasticities by income bracket. There are no significant variations of elasticity estimates by income level. The own-price and expenditure elasticities for rice remain very high in these income submodels.

The parameters of the LA/AIDS and AIDS models with demographic and seasonal dummy variables are estimated by dropping the equation for FAFH. Homogeneity and symmetry conditions are imposed on the estimation. The iterative seemingly unrelated regression procedure (ITSUR) is applied in SAS for estimation. ITSUR runs less than 15 iterations to meet the convergence criteria of 0.0001 for all models.

Tables 4.6 and 4.7 show the elasticity estimates from the AIDS model with the inverse Mills ratios of rice, fats and oil, and FAFH, for which substantial numbers of households had zero consumption. Table 4.6 shows the results of uncompensated price elasticities and expenditure elasticity. The expenditure elasticity of rice exceeds one, which indicates that rice is a normal good. Rice is mildly complementary to all commodities except for FAFH. The results clearly indicate the substitutability between rice and FAFH. In fact, most estimated cross-price elasticities are numerically small, except for those associated with the price of FAFH. The results suggest a strong substitutability between FAFH and at-home consumption of bread, noodles, fresh meat, eggs, and fats and oil. In Table 4.7, the compensated price elasticities show mixed results. Rice is a substitute for fresh fish, while it is a complement for fresh meat consumed at home. In addition, a moderate substitution (with a cross-price elasticity larger than 0.1) appears to occur between fresh fish and fresh meat, fresh fish and vegetables, and fats and oil and vegetables. A moderate complementarity is estimated between rice and fats and oil.

In order to validate the robustness of these estimation results, the estimation results from OLS, Heckman's two-step, Tobit, the LA/AIDS and the AIDS models are compared. Table 4.8 compares the own-price elasticity estimates from all models. It is surprising that the uncompensated own-price elasticity for rice exceeds 1.7 in absolute term in the LA/AIDS and AIDS models. Furthermore, the high own-price elasticity of rice is robust across all models. The lowest estimate of own-price elasticity for rice is -1.2 in the conditional estimates of Heckman's two-step and Tobit estimators.

TABLE 4.3
Whole sample elasticities for 11 major food products (OLS)

Food item	Mean budget share	Own-price elasticity	Expenditure elasticity
Non-glutinous rice	8.05%	-1.824 (0.029)	1.076 (0.009)
Bread	5.56%	-0.706 (0.003)	0.474 (0.005)
Noodles	3.83%	-0.607 (0.008)	0.493 (0.007)
Fresh fish	13.14%	-0.703 (0.005)	0.843 (0.005)
Fresh meat	12.43%	-0.518 (0.006)	0.713 (0.004)
Milk	4.71%	-0.106 (0.012)	0.569 (0.007)
Eggs	1.89%	-0.433 (0.006)	0.411 (0.005)
Fresh vegetables	14.30%	-0.770 (0.005)	0.682 (0.003)
Fresh fruits	7.94%	-0.660 (0.006)	0.960 (0.006)
Fats and oils	0.86%	-0.925 (0.014)	0.778 (0.016)
FAFH	27.29%	-2.523 (0.171)	1.655 (0.005)

Notes: The numbers in parentheses following the elasticity estimates are standard errors. All estimates are statistically significant at the 5 percent level.

Fresh fish has a higher own-price elasticity than fresh meat in all models. There are some possible reasons behind this finding. First of these is the importance of fish in the Japanese diet. Japan's fish eating culture has induced a wide range of variations in fish prices and consumption levels. In addition, there are many varieties and uses of fish. These varieties offer many substitution opportunities, which tend to result in higher own-price elasticity.

The low elasticities for milk and eggs are expected: there is little variation in price for these products. Although dairy products are becoming more popular, there are still only few varieties of them.

Table 4.9 presents a comparison of expenditure elasticity estimates across all models. The results are robust across the models. The largest expenditure elasticity for rice is 1.472 in the LA/AIDS model with the Stone price index, while the smallest is the 1.065 estimated from the AIDS model. This result is somewhat surprising; if rice is a staple food, an expenditure elasticity of 1.0 to 1.4 is fairly high. In every model estimated, rice and FAFH are the only two food items to have expenditure elasticities exceeding one. With respect to rice, this result is contrary to expectations. Combining this finding with the results from Table 4.8, there is a possibility that rice is no longer a staple food.

It is interesting to note that fresh fish has a higher expenditure elasticity than fresh meat, and this pattern is robust across the estimated models. Again, this result shows the importance of fish in the Japanese diet. Recently, meat consumption has been increasing, while the high price and expenditure elasticities show that consumers are sensitive to fish prices and their own incomes when they determine consumption patterns. Another possibility is that processed meats, such as ham, sausage and bacon, are not included in the fresh meat category. The inclusion of processed meats might change the result.

TABLE 4.4
Expenditure elasticities by income bracket (OLS)

Food Items	Income level (thousand yen)									
	Income 1 < 402		Income 2 402–568		Income 3 568–745		Income 4 745–999		Income 5 > 999	
	Mean Budget share	Elasticity estimate	Mean Budget share	Elasticity estimate	Mean Budget share	Elasticity estimate	Mean Budget share	Elasticity estimate	Mean Budget share	Elasticity estimate
Non-glutinous rice	10.21%	1.109 (0.017)	8.06%	1.185 (0.020)	7.45%	1.168 (0.021)	7.47%	1.178 (0.022)	6.84%	1.157 (0.021)
Bread	5.66%	0.502 (0.012)	5.85%	0.468 (0.013)	5.75%	0.450 (0.012)	5.61%	0.451 (0.013)	4.92%	0.445 (0.012)
Noodle	4.16%	0.525 (0.015)	4.11%	0.536 (0.015)	4.00%	0.535 (0.016)	3.71%	0.493 (0.016)	3.14%	0.485 (0.017)
Fresh fish	14.33%	0.948 (0.010)	12.75%	0.878 (0.011)	12.42%	0.846 (0.012)	12.78%	0.806 (0.012)	13.31%	0.714 (0.011)
Fresh meat	11.88%	0.797 (0.010)	12.39%	0.708 (0.009)	12.61%	0.673 (0.010)	12.72%	0.682 (0.010)	12.58%	0.666 (0.009)
Milk	5.00%	0.610 (0.015)	4.98%	0.536 (0.015)	4.75%	0.492 (0.016)	4.53%	0.540 (0.016)	4.23%	0.495 (0.015)
Eggs	2.05%	0.406 (0.012)	1.96%	0.427 (0.012)	1.91%	0.413 (0.013)	1.83%	0.404 (0.012)	1.68%	0.393 (0.013)
Fresh vegetables	15.92%	0.719 (0.007)	14.47%	0.685 (0.008)	13.72%	0.674 (0.008)	13.58%	0.657 (0.008)	13.65%	0.618 (0.008)
Fresh fruits	9.08%	0.982 (0.013)	7.70%	0.919 (0.015)	7.40%	0.923 (0.016)	7.39%	0.931 (0.016)	8.02%	0.947 (0.016)
Fats andoOil	0.99%	0.839 (0.035)	0.91%	0.824 (0.037)	0.84%	0.802 (0.036)	0.83%	0.775 (0.039)	0.74%	0.770 (0.040)
FAFH	20.73%	1.698 (0.013)	26.82%	1.645 (0.011)	29.14%	1.630 (0.011)	29.54%	1.625 (0.011)	30.89%	1.644 (0.010)

Notes: The numbers in parentheses underneath the elasticity estimates are standard errors. All estimates are statistically significant at the 5 percent level.

The expenditure elasticity for fresh fruits is relatively high. This might be a reflection of the fact that fruits are relatively expensive among the goods in the survey. In the marketplace, there are always more expensive fruits than the ones that a consumer purchases. Furthermore, some fruits might be purchased as gifts. Because of this, a high expenditure elasticity might not reflect the true behaviour of at-home consumers.

Table 4.10 shows the income elasticities for all models. All expenditure elasticity estimates are linearly transformed to the income elasticity using Equation 3.6 from Chapter 3. In all estimations, the results show that Japanese rice is a normal good, and its income elasticity is in the range of 0.30 to

0.42. The results also show that only FAFH has a higher income elasticity than rice, with estimates ranging from 0.418 to 0.530. This result is robust across models. The estimated income elasticities indicate that none of the food items are luxury goods in Japan. When rice is expected to be a staple food, it may seem surprising that its income elasticity is greater than those of fish, meat, fruits or vegetables. However, the robustness of the econometric results, rather than intuition, should be used for reaching conclusions on the rice demand pattern in Japan.

TABLE 4.5
Own-price elasticities by income bracket (OLS)

	Income level (thousand yen)									
	Income 1 < 402		Income 2 402–568		Income 3 568–745		Income 4 745–999		Income 5 > 999	
Food Items	Mean Budget share	Elasticity estimate	Mean Budget share	Elasticity estimate	Mean Budget share	Elasticity estimate	Mean Budget share	Elasticity estimate	Mean Budget share	Elasticity estimate
Non-glutinous rice	10.21%	-1.551 (0.058)	8.06%	-1.906 (0.067)	7.45%	-1.865 (0.069)	7.47%	-1.751 (0.066)	6.84%	-1.886 (0.065)
Bread	5.66%	-0.710 (0.008)	5.85%	-0.683 (0.007)	5.75%	-0.706 (0.007)	5.61%	-0.717 (0.007)	4.92%	-0.721 (0.007)
Noodles	4.16%	-0.647 (0.017)	4.11%	-0.616 (0.016)	4.00%	-0.614 (0.017)	3.71%	-0.557 (0.017)	3.14%	-0.587 (0.018)
Fresh fish	14.33%	-0.712 (0.010)	12.75%	-0.704 (0.011)	12.42%	-0.675 (0.011)	12.78%	-0.72 (0.011)	13.31%	-0.7054 (0.011)
Fresh meat	11.88%	-0.571 (0.013)	12.39%	-0.551 (0.012)	12.61%	-0.498 (0.013)	12.72%	-0.503 (0.012)	12.58%	-0.4535 (0.012)
Milk	5.00%	-0.025 (0.027)	4.98%	-0.152 (0.026)	4.75%	-0.094 (0.027)	4.53%	-0.182 (0.026)	4.23%	-0.073 (0.025)
Eggs	2.05%	-0.433 (0.013)	1.96%	-0.441 (0.012)	1.91%	-0.455 (0.012)	1.83%	-0.436 (0.012)	1.68%	-0.409 (0.013)
Fresh vegetables	15.92%	-0.790 (0.010)	14.47%	-0.782 (0.011)	13.72%	-0.787 (0.012)	13.58%	-0.733 (0.012)	13.65%	-0.754 (0.012)
Fresh fruits	9.08%	-0.662 (0.013)	7.70%	-0.678 (0.014)	7.40%	-0.675 (0.014)	7.39%	-0.655 (0.014)	8.02%	-0.628 (0.015)
Fats and oil	0.99%	-0.891 (0.031)	0.91%	-0.972 (0.030)	0.84%	-0.946 (0.028)	0.83%	-0.863 (0.030)	0.74%	-0.928 (0.032)
FAFH	20.73%	-3.511 (0.486)	26.82%	-2.525 (0.393)	29.14%	-1.721 (0.360)	29.54%	-1.933 (0.354)	30.89%	-2.973 (0.344)

Notes: The numbers in parentheses underneath the elasticity estimates are standard errors. All estimates are statistically significant at the 5 percent level.

Table 4.11 reports the coefficients for demographic variables from the AIDS model. For rice, households with elderly heads or more family members tend to have higher budget shares for rice. On the other hand, households with more wage earners or children tend to have lower budget shares for rice. Households with young heads tend to have higher budget shares for bread, noodles and meat than households with older heads. Households with children of any age tend to consume more bread, noodles and milk, but less fish, vegetables and fruits than those without any children. Table 4.12 shows the coefficients for regional dummy variables. The Okinawa dummy is omitted from the model. It can be noted that all regional dummy variables for rice have a negative coefficient, implying that the budget share of rice is smaller in all other regions than in Okinawa. Tyugoku and Tohoku regions have the smallest budget shares for rice.

TABLE 4.6

Uncompensated price and expenditure elasticities: AIDS model with inverse Mills ratio

Food items	Mean budget share	Uncompensated price elasticity											Expenditure elasticity
		Rice	Bread	Noodles	Fish	Meat	Milk	Eggs	Veg.	Fruits	Oil	FAFH	
Non-glutinous rice	8.05%	-1.736	-0.050	-0.046	-0.089	-0.172	-0.006	-0.007	-0.137	-0.048	-0.030	1.256	1.065
Bread	5.56%	-0.106	-0.708	0.003	-0.052	-0.018	-0.080	-0.016	-0.077	-0.077	-0.012	0.639	0.503
Noodles	3.83%	-0.131	0.007	-0.618	-0.085	-0.078	-0.066	-0.019	-0.096	-0.073	-0.012	0.657	0.513
Fresh fish	13.14%	-0.075	0.034	0.012	-0.705	0.049	0.002	0.011	-0.007	-0.060	-0.005	-0.111	0.855
Fresh meat	12.43%	-0.125	-0.034	-0.043	-0.038	-0.519	-0.082	-0.025	-0.089	-0.029	-0.016	0.272	0.728
Milk	4.71%	-0.046	-0.060	-0.032	-0.085	-0.124	-0.111	-0.009	-0.059	-0.110	0.006	0.060	0.569
Eggs	1.89%	-0.072	-0.035	-0.032	-0.070	-0.080	-0.047	-0.438	-0.011	-0.064	-0.011	0.435	0.424
Fresh vegetables	14.30%	-0.101	-0.014	-0.016	-0.076	-0.021	-0.025	0.002	-0.765	-0.069	0.009	0.383	0.694
Fresh fruits	7.94%	-0.063	-0.001	0.000	-0.076	0.025	-0.030	0.005	-0.046	-0.677	0.000	-0.087	0.948
Fats and oil	0.86%	-0.293	-0.094	-0.062	-0.139	-0.233	0.012	-0.032	0.103	-0.030	-0.914	0.874	0.809
FAFH	27.29%	0.443	-0.023	-0.009	0.010	-0.139	-0.065	-0.025	0.011	0.049	0.015	-1.907	1.640

TABLE 4.7

Compensated price elasticities: AIDS model with inverse Mills ratio

Food items	Mean budget share	Hicksian compensated price elasticity										
		Rice	Bread	Noodles	Fish	Meat	Milk	Eggs	Veg.	Fruits	Oil	FAFH
Non-glutinous rice	8.05%	-1.650	0.009	-0.005	0.050	-0.039	0.044	0.013	0.015	0.036	-0.021	1.547
Bread	5.56%	-0.066	-0.680	0.023	0.015	0.044	-0.056	-0.007	-0.005	-0.037	-0.008	0.777
Noodles	3.83%	-0.090	0.035	-0.598	-0.018	-0.014	-0.042	-0.009	-0.022	-0.032	-0.007	0.797
Fresh fish	13.14%	-0.006	0.081	0.045	-0.593	0.155	0.042	0.027	0.116	0.008	0.002	0.122
Fresh meat	12.43%	-0.066	0.006	-0.015	0.058	-0.429	-0.048	-0.011	0.015	0.028	-0.010	0.471
Milk	4.71%	0.000	-0.028	-0.010	-0.010	-0.053	-0.084	0.002	0.023	-0.065	0.011	0.216
Eggs	1.89%	-0.038	-0.011	-0.016	-0.014	-0.027	-0.027	-0.430	0.050	-0.030	-0.008	0.551
Fresh vegetables	14.30%	-0.045	0.024	0.011	0.015	0.065	0.007	0.015	-0.666	-0.014	0.015	0.572
Fresh fruits	7.94%	0.014	0.052	0.037	0.048	0.143	0.015	0.023	0.090	-0.602	0.008	0.172
Fats and oil	0.86%	-0.228	-0.049	-0.031	-0.033	-0.133	0.050	-0.017	0.218	0.034	-0.907	1.095
FAFH	27.29%	0.575	0.068	0.054	0.226	0.065	0.012	0.006	0.245	0.179	0.030	-1.460

TABLE 4.8
Comparison of own-price elasticities

Food items	Mean budget share	% of zero cons	Working Leser (OLS)	Heckit		Tobit	
				Un-conditional	Conditional	Un-conditional	Conditional
Non-glutinous rice	8.05%	43.75%	-1.824 (0.029)	-1.845	-1.234	-1.705	-1.286
Bread	5.56%	4.15%	-0.706 (0.003)	-0.721	-0.791	-0.751	-0.825
Noodles	3.83%	6.14%	-0.607 (0.008)	-0.664	-0.774	-0.702	-0.816
Fresh fish	13.14%	2.45%	-0.703 (0.005)	-0.694	-0.764	-0.734	-0.797
Fresh meat	12.43%	1.92%	-0.518 (0.006)	-0.546	-0.628	-0.542	-0.623
Milk	4.71%	8.36%	-0.106 (0.012)	-0.389	-0.683	-0.296	-0.565
Eggs	1.89%	5.51%	-0.433 (0.006)	-0.632	-0.812	-0.509	-0.657
Fresh vegetables	14.30%	0.24%	-0.770 (0.005)	-0.781	-0.811	-0.776	-0.799
Fresh fruits	7.94%	5.50%	-0.660 (0.006)	-0.685	-0.783	-0.739	-0.834
Fats and oil	0.86%	42.12%	-0.925 (0.014)	-0.782	-0.867	-1.157	-1.055
FAFH	27.29%	12.65%	-2.523 (0.171)	-2.766	-2.090	-2.585	-2.130

TABLE 4.8 (CONTINUED)

	Mean budget share	% of zero cons	LA/AIDS								AIDS	
			Stone price index				Laspeyres price index					
			without IMRs		with IMRs		without IMRs		with IMRs		with IMRs	
Food items			Uncom-pensated	Com-pensated	Uncom-pensated	Com-pensated	Uncom-pensated	Com-pensated	Uncom-pensated	Com-pensated	Uncom-pensated	Com-pensated
Non-glutinous rice	8.05%	43.75%	-1.801 (0.028)	-1.682 (0.028)	-1.781 (0.020)	-1.681 (0.020)	-1.792 (0.028)	-1.705 (0.028)	-1.769 (0.020)	-1.683 (0.020)	-1.736	-1.650
Bread	5.56%	4.15%	-0.721 (0.003)	-0.695 (0.003)	-0.721 (0.003)	-0.696 (0.003)	-0.706 (0.003)	-0.680 (0.003)	-0.706 (0.003)	-0.680 (0.003)	-0.708	-0.680
Noodles	3.83%	6.14%	-0.620 (0.008)	-0.597 (0.008)	-0.618 (0.008)	-0.596 (0.008)	-0.615 (0.008)	-0.596 (0.008)	-0.614 (0.008)	-0.595 (0.008)	-0.618	-0.598
Fresh fish	13.14%	2.45%	-0.670 (0.005)	-0.583 (0.005)	-0.674 (0.005)	-0.587 (0.005)	-0.670 (0.005)	-0.559 (0.005)	-0.673 (0.005)	-0.562 (0.005)	-0.705	-0.593
Fresh meat	12.43%	1.92%	-0.538 (0.005)	-0.460 (0.005)	-0.534 (0.005)	-0.457 (0.005)	-0.543 (0.005)	-0.454 (0.005)	-0.539 (0.005)	-0.450 (0.005)	-0.519	-0.429
Milk	4.71%	8.36%	-0.129 (0.012)	-0.087 (0.012)	-0.129 (0.012)	-0.087 (0.012)	-0.101 (0.012)	-0.075 (0.012)	-0.101 (0.012)	-0.074 (0.012)	-0.111	-0.084
Eggs	1.89%	5.51%	-0.448 (0.005)	-0.438 (0.005)	-0.448 (0.005)	-0.437 (0.005)	-0.445 (0.005)	-0.437 (0.005)	-0.444 (0.005)	-0.436 (0.005)	-0.438	-0.430
Fresh vegetables	14.30%	0.24%	-0.789 (0.005)	-0.668 (0.005)	-0.786 (0.005)	-0.666 (0.005)	-0.770 (0.005)	-0.672 (0.005)	-0.769 (0.005)	-0.671 (0.005)	-0.765	-0.666
Fresh fruits	7.94%	5.50%	-0.657 (0.006)	-0.565 (0.006)	-0.657 (0.006)	-0.564 (0.006)	-0.648 (0.006)	-0.572 (0.006)	-0.648 (0.006)	-0.572 (0.006)	-0.677	-0.602
Fats and oil	0.86%	42.12%	-0.901 (0.013)	-0.894 (0.013)	-0.912 (0.012)	-0.905 (0.012)	-0.902 (0.013)	-0.895 (0.013)	-0.912 (0.012)	-0.905 (0.012)	-0.914	-0.907
FAFH	27.29%	12.65%	-1.909	-1.515	-1.951	-1.535	-1.895	-1.443	-1.900	-1.448	-1.907	-1.460

Notes: The numbers in parentheses underneath the elasticity estimates are standard errors. All estimates are statistically significant at the 5 percent level.

TABLE 4.9
Comparison of expenditure elasticities

Food items	Mean budget share	% of zero cons	Working Leser (OLS)	Heckit		Tobit		LA/AIDS				AIDS
				Un-cond.	Cond.	Un-cond.	Cond.	Stone		Laspeyres		
								without IMRs	with IMRs	without IMRs	with IMRs	with IMRs
Non-glutinous rice	8.05%	43.75%	1.076 (0.009)	1.436	1.121	1.318	1.129	1.472 (0.008)	1.249 (0.006)	1.080 (0.009)	1.078 (0.006)	1.065
Bread	5.56%	4.15%	0.474 (0.005)	0.486	0.614	0.545	0.679	0.460 (0.005)	0.452 (0.005)	0.475 (0.005)	0.475 (0.005)	0.503
Noodles	3.83%	6.14%	0.493 (0.007)	0.536	0.688	0.608	0.758	0.583 (0.007)	0.573 (0.007)	0.495 (0.007)	0.495 (0.007)	0.513
Fresh fish	13.14%	2.45%	0.843 (0.005)	0.766	0.820	0.867	0.899	0.660 (0.004)	0.658 (0.004)	0.843 (0.005)	0.843 (0.005)	0.855
Fresh meat	12.43%	1.92%	0.713 (0.004)	0.656	0.718	0.733	0.780	0.629 (0.004)	0.623 (0.004)	0.717 (0.004)	0.717 (0.004)	0.728
Milk	4.71%	8.36%	0.569 (0.007)	0.724	0.856	0.678	0.801	0.883 (0.007)	0.888 (0.007)	0.567 (0.007)	0.567 (0.007)	0.569
Eggs	1.89%	5.51%	0.411 (0.005)	0.642	0.816	0.496	0.648	0.570 (0.005)	0.556 (0.005)	0.416 (0.005)	0.416 (0.005)	0.424
Fresh vegetables	14.30%	0.24%	0.682 (0.003)	0.678	0.722	0.690	0.722	0.851 (0.003)	0.836 (0.003)	0.689 (0.003)	0.688 (0.003)	0.694
Fresh fruits	7.94%	5.50%	0.960 (0.006)	0.864	0.906	0.999	0.999	1.163 (0.006)	1.175 (0.006)	0.960 (0.006)	0.960 (0.006)	0.948
Fats and oil	0.86%	42.12%	0.778 (0.016)	0.652	0.788	1.077	1.027	0.904 (0.016)	0.862 (0.015)	0.799 (0.016)	0.795 (0.015)	0.809
FAFH	27.29%	12.65%	1.655 (0.005)	1.830	1.513	1.716	1.511	1.446	1.524	1.655	1.656	1.640

Notes: The numbers in parentheses underneath the elasticity estimates are standard errors. All estimates are statistically significant at the 5 percent level.

Table 4.10
Comparison of income elasticities

	Working	Heckit		Tobit		LA/AIDS				AIDS
	Leser	Un-	Cond.	Un-	Cond.	Stone		Laspeyres		
Food items	(OLS)	cond.		cond.		without IMRs	with IMRs	without IMRs	with IMRs	with IMRs
Non-glutinous rice	0.311	0.416	0.324	0.382	0.327	0.426	0.362	0.312	0.312	0.308
Bread	0.137	0.141	0.178	0.158	0.197	0.133	0.131	0.137	0.137	0.146
Noodles	0.143	0.155	0.199	0.176	0.219	0.169	0.166	0.143	0.143	0.148
Fresh fish	0.244	0.222	0.237	0.251	0.260	0.191	0.190	0.244	0.244	0.248
Fresh meat	0.206	0.190	0.208	0.212	0.226	0.182	0.180	0.207	0.207	0.211
Milk	0.165	0.209	0.248	0.196	0.232	0.256	0.257	0.164	0.164	0.165
Eggs	0.119	0.186	0.236	0.144	0.188	0.165	0.161	0.120	0.120	0.123
Fresh vegetables	0.197	0.196	0.209	0.200	0.209	0.246	0.242	0.199	0.199	0.201
Fresh fruits	0.278	0.250	0.262	0.289	0.289	0.337	0.340	0.278	0.278	0.274
Fats and oil	0.225	0.189	0.228	0.312	0.297	0.262	0.249	0.231	0.230	0.234
FAFH	0.479	0.530	0.438	0.497	0.437	0.418	0.441	0.479	0.479	0.475

TABLE 4.11
Coefficients for demographic variables from AIDS model

Food items	Log of age of household head	Log of household size	Number of wage earners	Number of children aged 5 or under	aged between 6 and 12	aged between 13 and 18
Non-glutinous rice	0.046 (0.001)	0.017 (0.001)	-0.004 (0.000)	-0.007 (0.001)	-0.009 (0.000)	-0.003 (0.001)
Bread	-0.003 (0.001)	0.016 (0.001)	-0.001 (0.000)	0.006 (0.000)	0.003 (0.000)	0.006 (0.000)
Noodles	-0.003 (0.001)	0.015 (0.001)	0.000 (0.000)	0.000 (0.000)	0.002 (0.000)	0.004 (0.000)
Fresh fish	0.082 (0.001)	0.041 (0.001)	-0.002 (0.000)	-0.018 (0.001)	-0.022 (0.001)	-0.016 (0.001)
Fresh meat	-0.028 (0.001)	0.070 (0.001)	0.003 (0.000)	-0.014 (0.001)	-0.010 (0.000)	0.006 (0.001)
Milk	0.015 (0.001)	0.017 (0.001)	-0.003 (0.000)	0.008 (0.000)	0.002 (0.000)	0.005 (0.000)
Eggs	0.001 (0.000)	0.009 (0.000)	0.000 (0.000)	-0.001 (0.000)	0.000 (0.000)	0.001 (0.000)
Fresh vegetables	0.039 (0.001)	0.038 (0.001)	-0.006 (0.000)	-0.014 (0.001)	-0.018 (0.000)	-0.012 (0.001)
Fresh fruits	0.065 (0.001)	-0.010 (0.001)	-0.006 (0.000)	-0.001 (0.001)	-0.005 (0.000)	-0.006 (0.001)
Fats and oil	0.001 (0.000)	0.003 (0.000)	0.000 (0.000)	0.000 (0.000)	-0.001 (0.000)	0.000 (0.000)
FAFH						

Notes: The numbers in parentheses underneath the coefficient estimates are standard errors. All estimates are statistically significant at the 5 percent level.

TABLE 4.12
Coefficients for regional dummy variables from AIDS model

Food items	Hokkaido	Tohoku	Kanto	Hokuriku	Toukai	Kinki	Tyugoku	Shikoku	Kyushu
Non-glutinous rice	-0.012	-0.043	-0.032	-0.028	-0.024	-0.027	-0.044	-0.038	-0.029
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
Bread	-0.003	-0.003	0.008	0.009	0.006	0.019	0.015	0.013	0.003
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Noodle	0.005	0.008	0.007	0.008	0.005	0.008	0.007	0.012	0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Fresh fish	0.036	0.035	0.004	0.032	0.010	0.014	0.039	0.025	0.024
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Fresh meat	-0.023	-0.027	-0.023	-0.028	-0.016	0.010	-0.001	0.001	0.008
	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
Milk	0.002	0.002	0.004	0.004	0.003	0.006	0.005	0.003	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Eggs	-0.002	-0.001	-0.002	-0.001	-0.001	0.001	0.000	0.001	-0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Fresh vegetables	0.005	0.011	0.012	0.009	-0.005	0.003	-0.012	-0.008	-0.007
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
Fresh fruits	0.015	0.017	0.007	0.009	0.003	-0.006	0.005	0.009	0.002
	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)
Fats and oil	-0.007	-0.006	-0.005	-0.007	-0.007	-0.006	-0.005	-0.006	-0.006
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
FAFH									

Notes: The numbers in parentheses underneath the coefficient estimates are standard errors. All estimates are statistically significant at the 5 percent level. Okinawa is an omitted variable.

CONCLUDING REMARKS

This report estimates the Japanese demand for 11 major products: non-glutinous rice, bread, noodles, fresh fish and shellfish, fresh meat, milk, eggs, fresh vegetables, fresh fruits, fats and oil, and FAFH. The own-price, cross-price and expenditure elasticities of the 11 products are estimated, and some selected demographic variables are analysed. Contrary to previous studies on rice consumption patterns, the empirical results reported here show that own-price and expenditure elasticities for rice are high in absolute terms. In addition, these high elasticities are robust across different estimators. These results imply that Japanese rice is no longer a staple food, and rice has become more of a luxury food than many other foods. The econometric results also show that rice and FAFH are strong substitutes. The estimation results for other goods confirm that FAFH is a substitute for bread, noodles, fresh meat, eggs and fats and oil. These results are not surprising because this report utilizes purchase data, but they do imply the importance of FAFH in Japanese dietary patterns. Results from demographic variables show that Japanese food consumption patterns are different across household age groups: households with older heads tend to have more traditional dietary patterns, including a higher budget share for rice. The general dietary patterns of younger households can be characterized as Westernized: these households tend to consume more bread, noodles and meat, which are not traditional Japanese food items.

Using 1997 household survey data, econometric results indicate that traditional Japanese dietary patterns have changed. Rice is no longer a staple food, and FAFH plays an important role in food consumption. There is no evidence that rice is an inferior good. It may even be appropriate to change *a priori* expectations for grain consumption in high-income countries.

5. Meat demand analysis

INTRODUCTION

Meat and poultry consumption is becoming more important in the Japanese diet. Some studies report that Japanese diets have become increasingly Westernized: as per capita income increases, Japanese people consume more meats and poultry than grain products. As there is a limit to total calorie intake, the ratio of meat products to other foods is becoming larger than that of grain commodities. As reported in Chapter 4, fish and meat are moderate substitutes for each other (see Table 4.7). Furthermore, in June 1988, Japan signed the Beef Market Access Agreement (BMAA) with the United States. This agreement may have accelerated the increasing trend of Japanese beef consumption owing to the influx of cheaper beef from abroad. According to Persaud and Chern (1999), Japan's meat production began first to stagnate and then to fall, while meat imports rapidly increased after the agreement.

The main objectives of the following analysis of meat demand are to analyse meat consumption patterns and to conduct an econometric analysis of the meat demand structure in Japan. Cross-sectional household data from the 1997 FIES are used and estimations are based on a total of 94 200 observations. The meat items included are beef, pork, poultry, ground meat, ham, sausage and bacon. Fish is not included in this model because there are many heterogeneous groups of fish and, when the substitution patterns of the aggregate groups of meat and of fish were analysed (see Chapter 4), it was found that fresh meat and fresh fish were mild substitutes. A study by Eales and Wessells (1999) also found that meat and fish have not been weakly separable in recent years. The results of separability tests tend to be highly dependent on a particular database. Eales and Wessells used the time series data generated from the FIES for 1981 to 1995, and did not include high-value processed meats in their study. The results for testing separability may be different for the present report, which uses household-level data and includes other processed meats in the model. In any case, a weak separability between the seven meats and other foods – including fish – is assumed.

Much research has been conducted on the structural change of meat and poultry demand in Japan using time series data (Hayes, Wahl and Williams, 1990; Capps *et al.*, 1994; Eales and Wessells, 1999). After a decade of trade liberalization, it is extremely important to have an accurate estimate of Japanese meat and poultry demand elasticities. This report offers another estimation with cross-sectional data, which (as already noted) yield more reliable estimates of expenditure and income elasticities than time series data do. In this report, own-price, cross-price and expenditure elasticities are estimated by various single equation models and the almost ideal demand system (AIDS), developed by Deaton and Muellbauer (1980a; 1980b), as discussed in Chapter 3. These elasticity estimates are utilized to analyse Japanese consumption patterns of meat and its products.

REVIEW OF EXISING INFORMATION AND LITERATURE

Meat and poultry consumption in Japan over the last three decades has two main characteristics: an increasing trend in meat and poultry consumption; and a rapid increase of meat imports.

Historically, increases in per capita income in Japan have accelerated meat consumption. Figure 5.1 illustrates annual per capita beef, pork and poultry consumption and shows how per capita consumption of meats and poultry has been steadily increasing since 1960. Pork consumption increased until the early 1980s, but its growth seems to have levelled off thereafter. Over the last 30 years, the average consumption of beef has not increased as rapidly as that of pork and poultry.

However, the increase in beef consumption has accelerated since the mid-1980s, and in recent years beef has been increasing more rapidly than pork and poultry consumption. In 1960, per capita consumption of beef, pork and poultry was 1.1, 1.1 and 0.8 kg, respectively. Ten years later, beef consumption had nearly doubled, and pork and poultry consumption had increased fourfold. By 1980, beef consumption had tripled, and pork and poultry consumption had increased tenfold. By 1995, beef consumption was seven and a half times its 1960 level, and poultry consumption had increased by nearly 14 times.

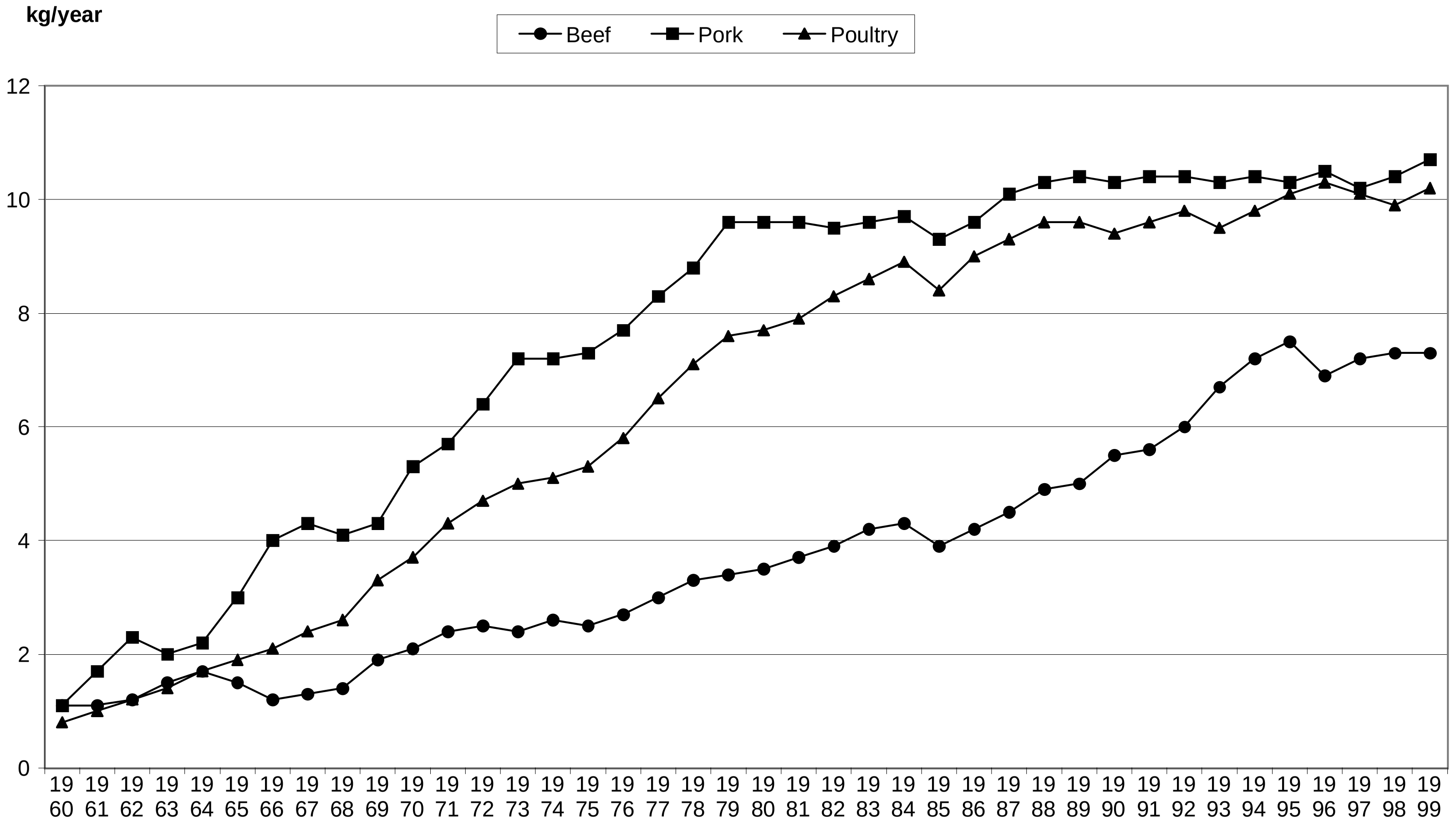
The Japanese Government protected beef producers with import quotas. Before the 1988 BMAA, all beef imports, except a small portion under the private quota, were monopolized by the Livestock Industries Promotion Corporation (LIPC) (see Hayami, 1979; Alston *et al.*, 1990). Under the BMAA, quotas were raised by 60 000 tonnes each year from April 1988 to April 1991 (Persaud and Chern, 1999). Thereafter, the quota restriction was replaced by an import tariff. This agreement significantly curtailed LIPC's intervention in the beef market. Consequently, the Japanese beef market became freer; the Japanese cattle industry had to adjust its supply and pricing to the market situation, and consumers enjoyed the benefits of increasing competition from foreign countries.

The increases in meat imports since the 1988 agreement have been remarkable.[9] Figure 5.2 illustrates the trends of beef, pork and poultry imports and shows how all meat imports increased rapidly after the mid-1980s, with beef imports surpassing pork imports during most of the 1990s. Poultry imports have been lower than those of beef and pork during the last three decades. As Figure 5.3 shows, domestic beef production has been stagnant since the mid-1980s, and beef imports have grown at an even faster rate than before. These figures clearly show that beef imports have exceeded domestic production since 1992. Given the historical restrictive beef quota and its trade liberalization in 1988, the relatively high growth rates of beef consumption were stimulated by increased imports in the late 1990s. Figure 5.3 also shows how the production of pork and poultry has decreased since the late 1980s. Figure 5.4 shows the yearly percentage change of nominal unit prices for beef, pork and poultry. Beef prices have been more volatile than those of pork and poultry. Since trade liberalization, beef prices have shown a downward trend, although the magnitude of this trend is not as large as might have been expected.

Food prices in Japan have generally been considered high, relative to other developed countries. Hayami (1979) reports the price differentials of food commodities based on 1977 data. Two decades ago, the retail price of beef in Tokyo was seven to nine times higher than in the capitals of other developed countries. In order to have an overview of the price differentials, MAFF regularly issues price comparisons for food items in major cities of the world. As shown on Table 5.1, which is based on 1996 data, beef is still more expensive in Tokyo than it is in other major cities, although the price differential ranges from twice to none. The pork price varies among major cities, and poultry is cheaper in Tokyo than in several other major cities. Combined with Hayami's survey, Table 5.1 shows that the price differentials among large cities in developed countries have decreased significantly over the last 20 years.

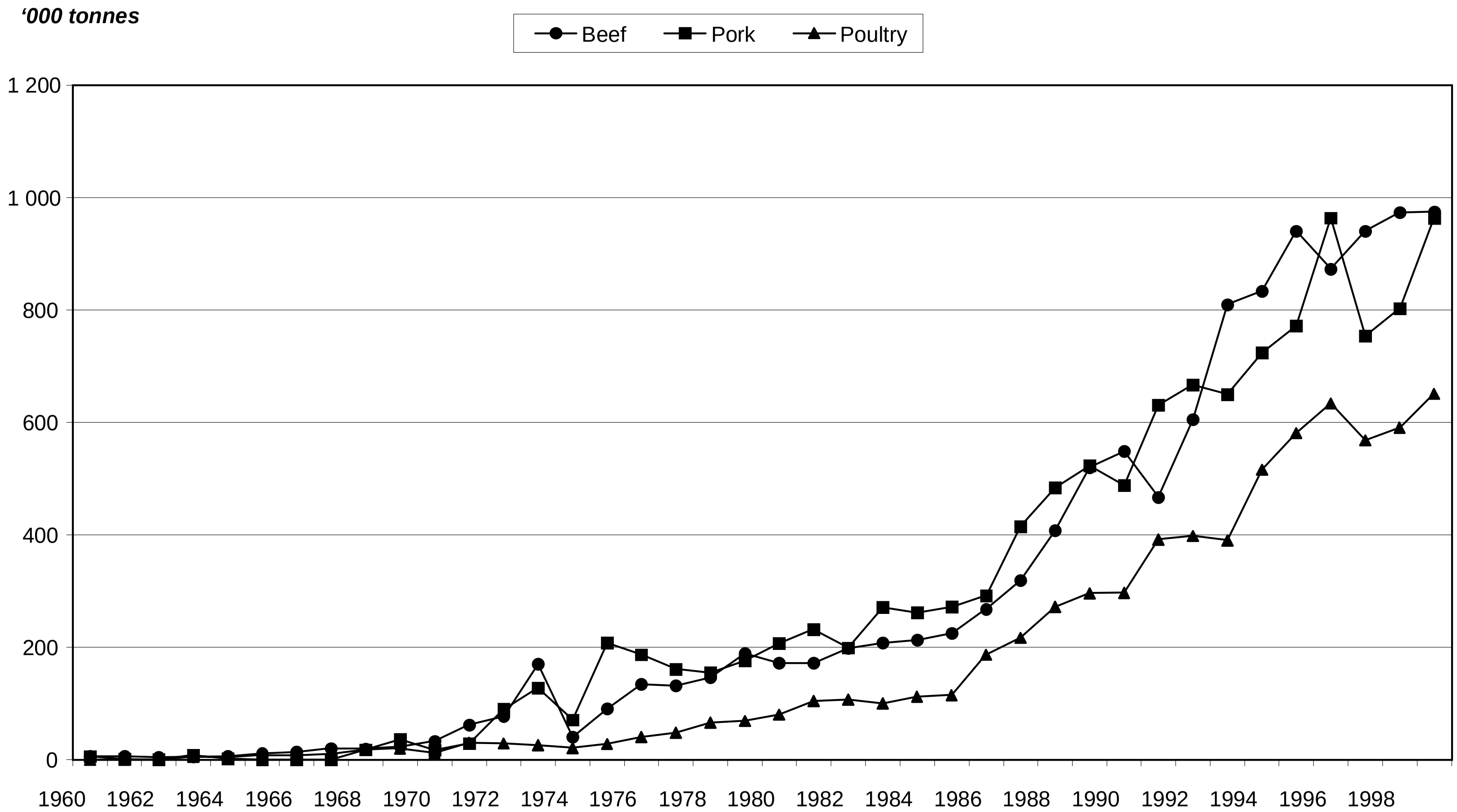
Estimation results on the own-price elasticities of meat demand in Japan, the United States and Canada vary considerably. Hayami (1979) investigated the consequences of Japanese beef trade liberalization and reported the results of own-price elasticities for beef from other studies: the results vary from -1.3 to -1.8. Applying the Rotterdam demand system, Sasaki (1995) estimated various meat demand elasticities in Japan. The own-price elasticities of beef, pork, poultry and meat products are -1.26, -1.53, -0.68 and -0.81, respectively. These results are consistent with Hayami's survey: beef and pork are highly price-elastic, while poultry is relatively inelastic.

Figure 5.1: Annual per capita beef, pork and poultry consumption, 1960–1999



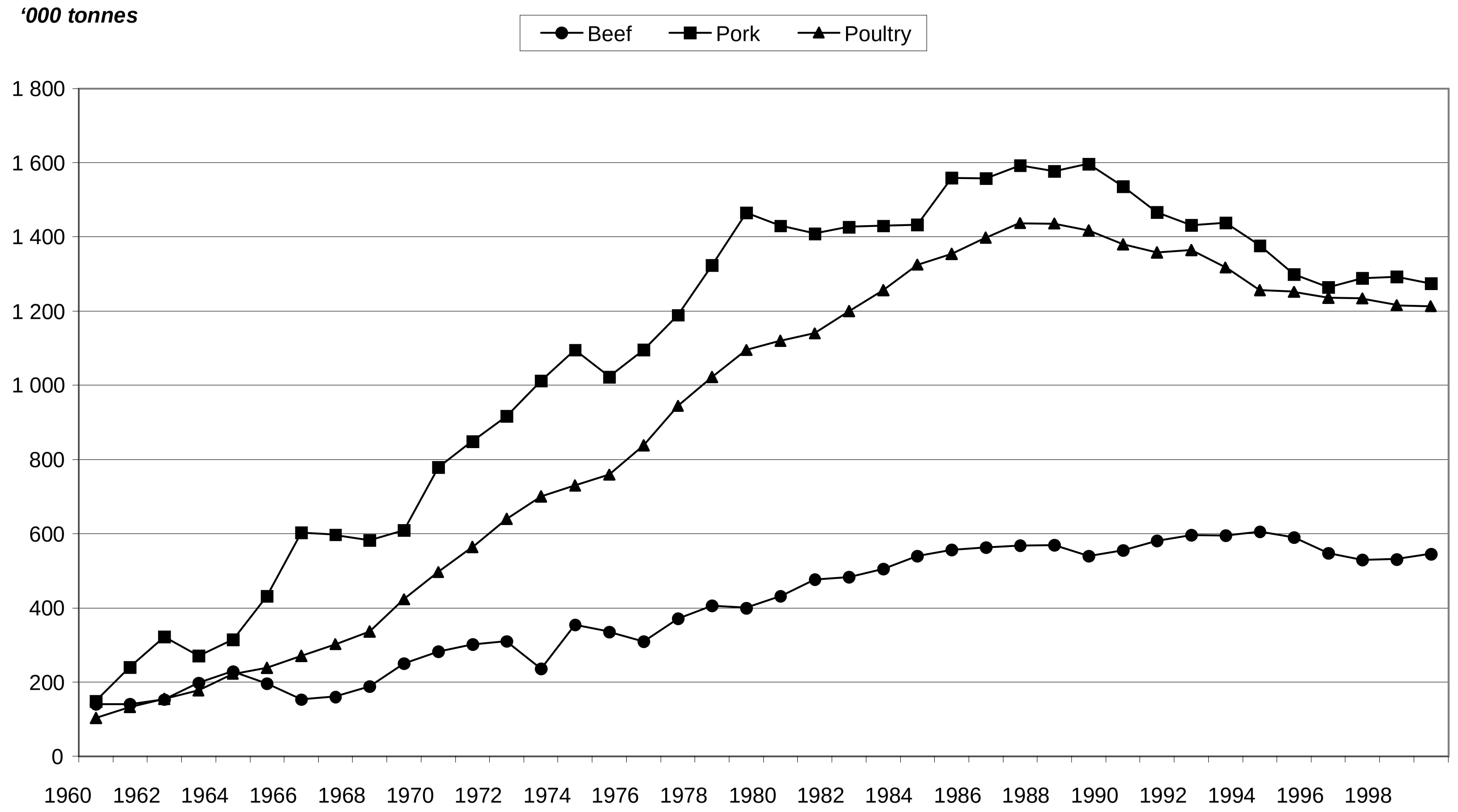
Source: MAFF, 2001.

Figure 5.2: Japanese imports of beef, pork and poultry, 1960–1999



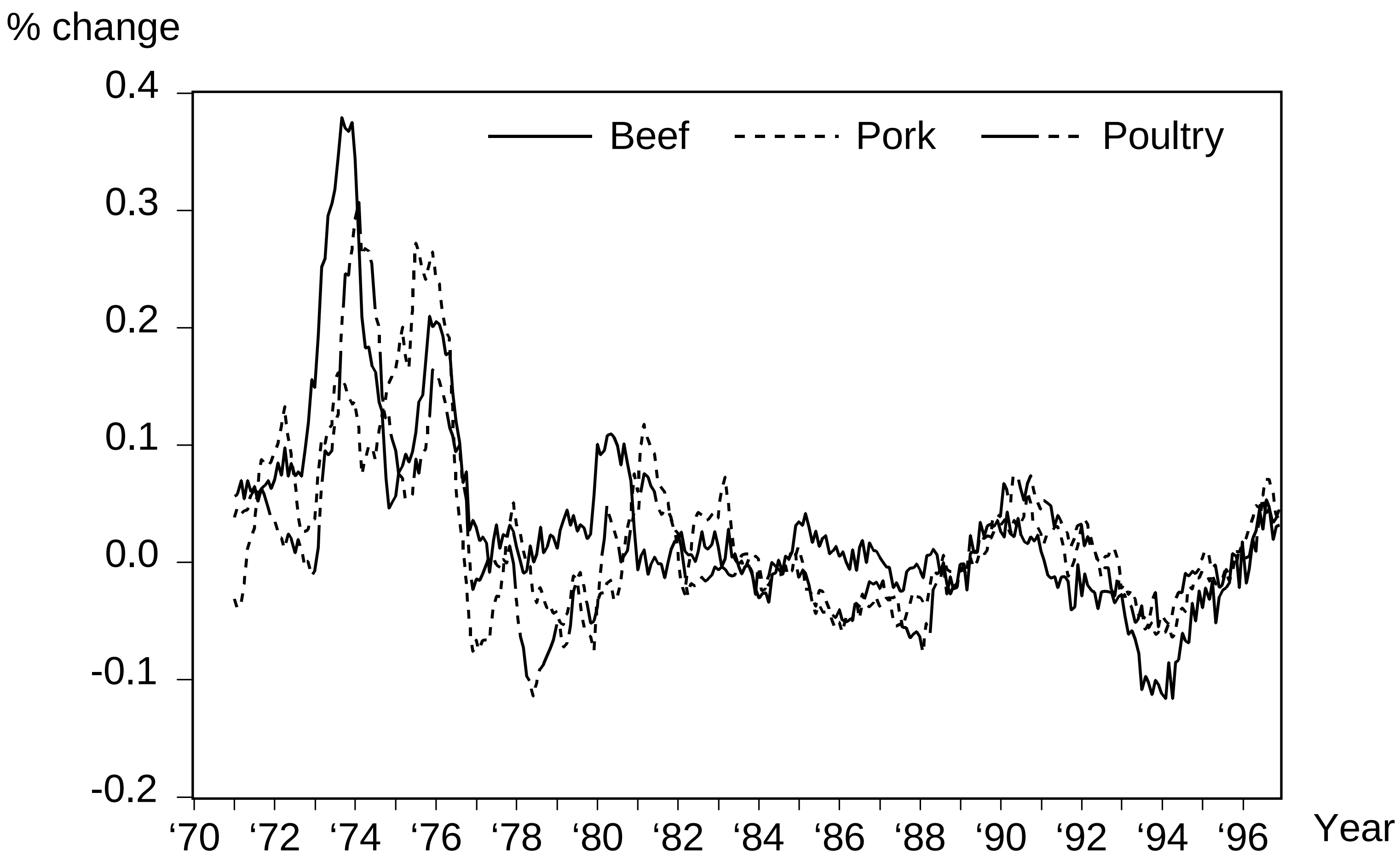
Source: MAFF, 2001.

Figure 5.3: Domestic production of beef, pork and poultry, 1960–1999



Source: MAFF, 2001.

Figure 5.4: Yearly percentage changes of beef, pork and poultry prices, 1970–1997



Source: FIES, various issues.

TABLE 5.1
International price comparison (November 1996)

Food item	United States New York	United Kingdom London	France Paris	Germany Hamburg	Switzerland Geneva
Beef	53	53	67	69	97
Pork	73	103	65	46	125
Chicken	115	199	144	173	201

Note: Price comparison with Tokyo (price in Tokyo = 100).
Source: MAFF, 1997.

There are many studies on United States and Canadian meat and poultry consumption. Eales and Unnevehr (1993) conducted a survey of meats and poultry demand elasticity studies in Canada. Table 5.2 shows excerpts from their results. In their survey, the estimates of own-price elasticity are considerably lower in absolute value than those from Hayami's study, particularly for beef and pork. Using the AIDS model estimated with United States data, Chen and Veeman (1991) reported own-price elasticities for beef, pork and poultry to be -0.77, -0.87 and -0.95, respectively. The Chen and Veeman study on United States meat demand yields estimates that are far closer to those obtained from Canadian data. The studies' comparisons between Western countries and Japan indicate that the own-price elasticities of meats and poultry are higher in Japan than in the United States and Canada.

TABLE 5.2
Canadian meat demand: own-price elasticity estimates (published in the 1990s)

Food item	No. of studies	Mean	Standard deviation	Minimum absolute value	Maximum absolute value
Beef	6	-0.76	0.23	0.40	1.08
Pork	6	-0.59	0.26	0.10	0.82
Chicken	6	-0.65	0.26	0.32	0.95

Source: Eales and Unnevehr, 1993, Table 4.

Expenditure elasticity is one of the key determinants of future meat demand, and it is important to have an accurate estimate of expenditure elasticity in order to forecast the medium- to long-term demand for meat. Eales and Unnevehr (1993) surveyed the results of Canadian expenditure elasticity studies. Table 5.3 shows part of their survey results. Using United States data, Moschini and Meilke (1989) reported various expenditure elasticities on meat demand. The estimated expenditure elasticities of beef, pork and poultry were, respectively, 1.39, 0.85 and 0.21 in the post-structural change period of the fourth quarter of 1975 and in the 1967–1987 data set. There are only slight differences between the estimates made from Canadian and those made from United States data. In the Eales and Unnevehr study, expenditure elasticities for beef, pork and poultry are positive, but only the beef expenditure elasticity exceeds one in the Moschini and Meilke study.

TABLE 5.3
Canadian meat demand: expenditure elasticity estimates (published in the 1990s)

Food item	No. of studies	Mean	Standard deviation	Minimum absolute value	Maximum absolute value
Beef	6	1.24	0.41	0.82	1.88
Pork	6	0.81	0.32	0.31	1.14
Chicken	6	0.57	0.36	0.18	1.04

Source: Eales and Unnevehr, 1993, Table 4.

Sasaki (1995) reported the income elasticities of meats and poultry in Japan, and found elasticities for beef, pork, poultry and other meat products of 0.80, 1.29, 1.42 and 2.10, respectively. It is interesting to note that Sasaki's study shows beef to be a normal good, although pork, poultry and meat products are superior goods. These results are quite different from the findings of the Canadian and United

States studies. Sasaki's estimates depend on the specification of the Rotterdam model and the use of time series data. In the present report, the AIDS model with cross-sectional data has been applied, which should yield more reliable estimates of expenditure elasticities.

EMPIRICAL RESULTS

The survey data used in this report consist of 94 200 observations for seven meat products. Price data are constructed for households with zero consumption (and thus zero budget share) according to their geographic location, the month of the survey and the household's income level, as described in Chapter 3. In order to have a consistent result, OLS, Heckman's two-step and Tobit estimators are compared. For system modelling, the LA/AIDS models with Stone and Laspeyres index is utilized, and the inverse Mills ratio is included to correct for the zero consumption problem. The full version of the AIDS model is also applied, and all results are compared. Both the LA/AIDS and the AIDS are estimated with homogeneity and symmetry conditions imposed.

Table 5.4 reports the comparison of estimated own-price elasticities: excluding sausage, beef has the most inelastic own-price elasticity among the seven meat commodities in the single equation models. These results indicate that Japanese consumers are insensitive to changes in the beef price. If beef were price-inelastic, the recent increases in beef consumption would not have been caused by price decreases, but either by per capita income increases or by substitution with other meat products. Table 5.5 reports the (Hicksian) compensated price elasticities obtained from the AIDS model with inverse Mills ratios for all seven variables. Most products are net substitutes. Only beef and ground meat show a negative Hicksian cross-price elasticity, which is caused by a net complementarity.

The estimates of expenditure elasticity are compared in Table 5.6. Among all meat products, only beef has an expenditure elasticity that exceeds one – those of other commodities are all less than one. This result is very similar to that found in the United States and Canadian studies reported by Eales and Unnevehr, and Moschini and Meilke. Sasaki's study, based on existing Japanese data, shows nearly the opposite results. From this study, it can be concluded that the Japanese meat consumption pattern has been Westernized in that expenditure elasticities have become similar to those estimated in North American countries. This preference change might have been caused by the increases in imported beef. The comparison of expenditure elasticities from various models reveals that results are robust. In addition, a high expenditure elasticity for beef indicates that beef consumption will not decrease dramatically as long as Japanese consumers maintain their high per capita income.

It is interesting to compare these estimates with those obtained by Eales and Wessells (1999) using the quarterly time series data for 1981 to 1995. Eales and Wessells tested the separability between meats and fish and estimated two models: one non-separable and one separable, including only meats (beef, pork and poultry). In fact, the estimated own-price and expenditure elasticities for beef, pork and poultry (Tables 5.4 to 5.6) estimated in this report are closer to the other estimates for the non-separable than for the separable model. For example, estimates of the own-price elasticities for beef range from -0.549 to -0.605, while Eales and Wessells obtained an estimate of -0.516 from their non-separable model and -0.166 from their separable model. There are other notable differences, including estimates of price elasticities in absolute value that are higher than those estimated by Eales and Wessells from their non-separable model, especially for pork and poultry. Expenditure elasticities are not strictly comparable because the models used by Eales and Wessells include other items in addition to beef, pork and poultry: the present report includes ground meat, ham, sausage and bacon, while Eales and Wessells include three categories of fish. Despite this difference, the estimates of expenditure elasticities are higher than those estimated by Eales and Wessells (1999).

Table 5.7 shows the estimation results of selected demographic variables obtained from the AIDS model. Considering the high expenditure elasticity for beef, it is reasonable to expect that the age of the household head and the number of wage earners in the household should have a positive impact on beef's budget share, while the expenditure on beef tends to decrease as the number of household members increases. The number of children shows negative impacts on the expenditure shares of beef, pork and poultry.

CONCLUDING REMARKS

This report estimates the Japanese demand for beef, pork, poultry and processed meat products. The own-price, cross-price and expenditure elasticities of seven meat products are estimated, and some selected demographic variables are analysed. The results indicate that recent Japanese consumption behaviour is similar to that of United States and Canadian consumers, as measured by elasticity estimates.

This study is based on 1997 cross-sectional household survey data. A decade has passed since the beef trade was liberalized. Beef is inelastic to price, and the expenditure elasticity of beef exceeds one. As it is a cross-sectional analysis, this report does not make it clear whether a structural change has occurred. Estimation results from time series data will reveal further information about structural changes to consumer preferences. This report uses expenditure elasticity to show that beef is the only superior good among seven meat commodities. In this regard, as with other reported estimates, Japanese preference in the late 1990s had become closer to that of Western nations.

TABLE 5.4
Comparison of own-price elasticities

Food items	Mean budget share	% of zero cons	Working Leser (OLS)	Heckit		Tobit		LA/AIDS with inverse Mills ratio				AIDS	
								Stone index		Laspeyres index			
				Un-cond	Cond	Un-cond	Cond	Uncom-pensated	Com-pensated	Uncom-pensated	Com-pensated	Uncom-pensated	Com-pensated
Beef	31.62%	20.63%	-0.597 (0.006)	-0.593	-0.686	-0.731	-0.825	-0.549 (0.004)	-0.173 (0.004)	-0.607 (0.004)	-0.202 (0.004)	-0.605	-0.197
Pork	29.57%	9.50%	-0.796 (0.010)	-0.807	-0.873	-0.823	-0.872	-0.722 (0.007)	-0.441 (0.007)	-0.708 (0.007)	-0.443 (0.007)	-0.723	-0.459
Poultry	15.25%	19.67%	-0.874 (0.012)	-1.080	-1.030	-0.931	-0.962	-0.779 (0.009)	-0.630 (0.009)	-0.775 (0.009)	-0.646 (0.009)	-0.785	-0.658
Ground meat	2.50%	70.37%	-1.261 (0.045)	-1.710	-1.131	-1.365	-1.092	-1.028 (0.025)	-1.003 (0.025)	-1.013 (0.025)	-0.989 (0.025)	-1.007	-0.983
Ham	8.05%	39.29%	-0.610 (0.018)	-1.405	-1.104	-0.947	-0.979	-0.691 (0.081)	-0.624 (0.013)	-0.708 (0.013)	-0.633 (0.013)	-0.716	-0.639
Sausage	9.59%	33.39%	-0.918 (0.017)	-0.109	-0.103	-0.101	-0.100	-0.823 (0.096)	-0.749 (0.012)	-0.829 (0.012)	-0.757 (0.012)	-0.830	-0.757
Bacon	3.41%	59.21%	-1.311 (0.031)	-1.890	-1.173	-1.422	-1.128	-1.201	-1.174	-1.212	-1.184	-1.211	-1.183

Note: The numbers in parentheses underneeath the elasticity estimates are standard errors.

TABLE 5.5
Hicksian compensated price elasticities of the AIDS model with inverse Mills ratio

	Hicksian compensated price elasticity						
Food items	**Beef**	**Pork**	**Poultry**	**Ground meat**	**Ham**	**Sausage**	**Bacon**
Beef	**-0.197**	**0.141**	**0.081**	**-0.030**	**0.032**	**-0.006**	**-0.020**
Pork	**0.099**	**-0.459**	**0.108**	**0.046**	**0.057**	**0.101**	**0.047**
Poultry	**0.107**	**0.204**	**-0.658**	**0.031**	**0.093**	**0.155**	**0.069**
Ground meat	**-0.013**	**0.411**	**0.081**	**-0.983**	**0.089**	**0.191**	**0.225**
Ham	**0.070**	**0.219**	**0.185**	**0.034**	**-0.639**	**0.072**	**0.059**
Sausage	**0.105**	**0.227**	**0.187**	**0.073**	**0.042**	**-0.757**	**0.123**
Bacon	**0.041**	**0.300**	**0.229**	**0.181**	**0.121**	**0.310**	**-1.183**

TABLE 5.6
Comparison of expenditure elasticities for meat products

Food items	Mean budget share	% of zero cons	Working Leser (OLS)	Heckit		Tobit		LA/AIDS		AIDS
				Un-cond.	Cond.	Un-cond.	Cond.	Stone with IMRs	Laspeyres with IMRs	with IMRs
Beef	31.62%	20.63%	1.291 (0.003)	1.151	1.116	1.415	1.270	1.191 (0.002)	1.284 (0.002)	1.289
Pork	29.57%	9.50%	0.894 (0.003)	0.900	0.934	0.942	0.958	0.950 (0.003)	0.897 (0.002)	0.893
Poultry	15.25%	19.67%	0.838 (0.004)	1.157	1.059	0.966	0.981	0.980 (0.004)	0.844 (0.004)	0.837
Ground meat	2.50%	70.37%	0.950 (0.010)	1.333	1.061	1.365	1.092	0.999 (0.007)	0.957 (0.007)	0.958
Ham	8.05%	39.29%	0.942 (0.007)	1.401	1.103	1.164	1.065	0.836 (0.006)	0.940 (0.005)	0.947
Sausage	9.59%	33.39%	0.752 (0.006)	0.832	0.939	0.959	0.982	0.771 (0.005)	0.756 (0.004)	0.753
Bacon	3.41%	59.21%	0.820 (0.009)	1.510	1.099	1.215	1.065	0.785	0.825	0.826

Note: The numbers in parentheses underneath the elasticity estimates are standard errors.

TABLE 5.7
Coefficients of demographic variables from the AIDS model

Demographic variable	Dependent variable: budget share of Beef	Pork	Chicken
Age of household head	0.0577*	0.0334*	0.0112*
Number in household	-0.0922*	0.0584*	0.0224*
Number of wage earners	0.0048*	-0.0021*	-0.0028*
Number of children 6–12 years old	-0.0038*	-0.0131*	-0.0034*
Number of children 13–18 years old	-0.0055*	-0.0027*	-0.0003

Note: An asterisk denotes statistically significance at the 5 percent level.

6. Conclusions

This report documents the research results from modelling Japanese household food consumption behaviour by using household-level data for 1997. The FIES data provide a rich source of information for estimating food demand in Japan. The report presents only two empirical food demand models: one for 11 aggregate foods, including rice; and one for seven meats. More can – and will – be done to learn more about Japanese food consumption behaviour from this database and from similar data for 1996.

This report presents analyses of descriptive statistics for food consumption by demographic groups and econometric estimations of the two food models. Several single equation demand models and the AIDS model are estimated.

The econometric results indicate that rice is not an inferior good in Japan, and that demographic variables are important indicators of the future trend of Japanese rice consumption. According to the meat demand analysis, Japanese dietary patterns have become increasingly Westernized.

One puzzling set of results is related to the estimated own-price elasticity of rice demand. The report's estimates of this elasticity range from -1.5 to -1.9, which are very high. Since this elasticity has important implications for the impacts of Japanese agricultural and trade policies, it needs to be assessed carefully. The reliability of the estimates can be seen from the fact that the range is relatively robust among several model specifications. It should be noted, however, that the survey data are observations of purchase behaviour, which may not be the same as consumption behaviour. This is especially true for rice because households buy rice in response to changes in price: substantial variations in rice prices among households and months were recorded. These differences might have been caused by quality differences; high-income households tend to buy higher-quality rice than lower-income households do. An attempt is made to address this question by estimating various demand models by income level, but the estimates of the own-price elasticity of rice remain very high. This report does not answer the question regarding differences between purchase and consumption. The issue is important and a more elaborate modelling framework, based on the concept of infrequency of purchase, should be used to address it.

Some of the findings contradict those of previous studies of aggregated time series data and shed more light on the continuing debate about the income and price effects of food demand, especially for rice in Japan. The results presented in this report should also be useful to agricultural policy-makers in assessing the impacts of various agricultural and trade policies.

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ANNEX A. DAILY CONSUMPTION OF RICE AND MEATS BY INCOME LEVEL AND AGE GROUP, 1997

Table A.1 Distribution of sample by income and age

		Income level (10 000 yen)					
		< 402	402–568	568–745	745–999	> 999	Total
Age	< 35	2 864	4 257	2 745	1 420	502	11 788
	35–44	2 341	4 125	5 638	4 664	2 854	19 622
	45–54	2 460	2 797	4 260	6 500	7 496	23 513
	55–64	4 158	3 686	3 694	3 944	5 691	21 173
	> 64	8 488	4 684	2 408	1 627	1 922	19 129
	Sum	20 311	19 549	18 745	18 155	18 465	95 225

Table A.2 Annual total household income by income and age (10 000 yen)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
Age	< 35	315.75	484.14	639.71	852.53	1 268.37
	35–44	304.03	494.39	655.79	848.31	1 300.36
	45–54	295.74	488.97	658.17	866.83	1 387.15
	55–64	294.65	483.90	650.39	863.04	1 432.65
	> 64	292.87	474.18	644.00	857.13	1 561.45

Table A.3 Household size by income and age

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
Age	< 35	3.15	3.32	3.28	3.30	3.48
	35–44	3.57	4.05	4.04	4.12	4.31
	45–54	3.18	3.47	3.76	3.80	3.90
	55–64	2.50	2.60	2.87	3.10	3.33
	> 64	2.21	2.27	2.68	3.07	3.39

Table A.4 Average age of household head by income and age

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
Age	< 35	28.56	30.34	30.90	31.22	31.98
	35–44	39.43	39.21	39.34	40.13	40.39
	45–54	49.26	49.02	48.98	49.13	49.82
	55–64	60.47	59.86	59.39	58.75	58.48
	> 64	72.22	70.86	69.99	70.44	70.13

Table A.5 Monthly total household expenditure by income and age (yen)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
Age	< 35	202 056	260 591	288 587	331 966	415 102
	35–44	224 581	277 936	328 340	375 026	470 749
	45–54	223 652	269 225	325 646	415 433	524 780
	55–64	219 407	261 680	299 592	365 478	465 894
	> 64	196 380	272 366	318 037	336 051	462 335

Table A.6 Monthly household food expenditure by income and age (yen)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
	< 35	49 073	59 903	67 305	73 700	88 659
Age	35–44	65 239	75 331	85 653	94 934	111 842
	45–54	68 540	79 237	89 199	98 529	109 600
	55–64	67 773	77 513	86 234	93 300	108 864
	> 64	62 813	79 545	88 384	97 717	114 788

Table A.7 Daily household consumption of non-glutinous rice by income and (g)

		Income level (10 000 yen)					
		< 402	402–568	568–745	745–999	> 999	Total
	< 35	137.60	141.45	137.46	146.16	132.72	141.08
Age	35–44	218.24	219.96	235.69	244.63	259.76	239.32
	45–54	279.73	293.76	324.71	340.66	332.32	327.92
	55–64	302.35	294.68	294.95	330.16	327.50	316.26
	> 64	269.05	292.21	285.17	304.05	320.13	289.03
All ages		258.19	243.15	266.36	307.45	309.34	267.64

Table A.8 Daily per capita consumption of non-glutinous rice by income and age (g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
	< 35	44.32	43.99	42.85	43.99	38.99
Age	35–44	62.69	54.60	58.44	59.79	61.10
	45–54	90.30	88.83	87.72	90.67	85.50
	55–64	125.45	116.46	107.33	112.19	101.48
	> 64	124.07	129.43	114.76	105.48	98.78

Table A.9 Daily household consumption of pork by income and age (g)

		Income level (10 000 yen)					
		< 402	402–568	568–745	745–999	> 999	Total
	< 35	30.67	35.73	34.46	34.10	37.45	34.08
Age	35–44	37.15	45.40	48.47	51.87	54.19	48.11
	45–54	42.31	46.36	54.44	54.63	57.33	53.18
	55–64	33.04	33.98	39.12	42.12	44.30	38.98
	> 64	24.50	25.75	31.52	37.95	38.39	28.23
All ages		30.63	37.98	45.76	49.64	53.01	46.50

Table A.10 Daily household consumption of beef by income and age (g)

		Income level (10 000 yen)					
		< 402	402–568	568–745	745–999	> 999	Total
	< 35	19.35	21.30	22.98	22.92	29.02	21.51
Age	35–44	28.30	31.09	33.03	36.76	39.47	34.14
	45–54	30.75	35.37	38.23	40.95	41.52	39.75
	55–64	22.43	25.84	29.79	33.14	33.84	30.10
	> 64	16.90	19.96	22.29	30.02	26.98	21.22
All ages		20.93	25.80	29.50	34.96	39.70	30.72

Table A.11 Daily household consumption of poultry by income and (g)

		Income level (10 000 yen)					
		< 402	402–568	568–745	745–999	> 999	Total
Age	< 35	27.16	30.25	27.94	29.02	27.19	28.68
	35–44	32.28	36.14	38.29	39.47	42.36	37.99
	45–54	33.66	37.02	42.86	41.52	41.90	40.53
	55–64	25.80	27.94	30.06	33.84	34.06	30.63
	> 64	19.19	21.07	23.48	26.98	31.36	22.08
All ages		24.56	29.95	34.96	36.81	39.39	35.03

Table A.12 Daily household consumption of ground meat by income and age (g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
Age	< 35	6.14	6.69	6.14	6.16	5.18
	35–44	7.01	7.17	7.46	7.77	8.10
	45–54	4.73	5.48	6.33	6.77	7.36
	55–64	2.30	2.43	3.26	3.76	4.18
	> 64	1.62	1.65	2.43	2.88	3.57

Table A.13 Daily household consumption of ham by income and age (g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
Age	< 35	4.52	6.27	6.72	7.06	6.76
	35–44	6.89	9.06	9.99	10.08	12.94
	45–54	7.30	8.23	10.27	10.82	11.21
	55–64	5.78	7.17	7.71	9.32	9.13
	> 64	5.32	6.32	7.54	8.93	9.87

Table A.14 Daily household consumption of sausage by income and age (g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
Age	< 35	12.68	15.12	14.10	13.49	13.90
	35–44	16.43	20.28	20.29	20.93	20.22
	45–54	11.69	14.23	16.65	16.27	16.15
	55–64	7.85	8.76	10.13	11.08	11.18
	> 64	5.03	5.97	7.52	10.32	11.47

Table A.15 Daily household consumption of bacon by income and age (g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
Age	< 35	3.30	3.95	3.76	3.67	3.87
	35–44	3.57	4.39	4.80	5.32	5.58
	45–54	3.53	3.64	4.47	4.81	5.18
	55–64	2.60	2.59	2.90	3.38	3.50
	> 64	1.71	2.15	2.37	3.48	3.40

Table A.16 Price of non-glutinous rice by income and age (yen/100 g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
Age	< 35	44.88	45.84	47.47	47.97	49.59
	35–44	46.09	45.53	46.42	47.79	49.82
	45–54	46.60	47.08	47.14	47.74	49.10
	55–64	48.05	48.46	48.84	48.95	50.77
	> 64	49.20	50.20	50.53	50.94	52.49

Table A.17 Price of pork by income and age (yen/g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
Age	< 35	1.32	1.36	1.41	1.43	1.52
	35–44	1.33	1.37	1.42	1.45	1.54
	45–54	1.42	1.47	1.45	1.50	1.57
	55–64	1.49	1.54	1.57	1.57	1.64
	> 64	1.56	1.64	1.65	1.68	1.70

Table A.18 Price of beef by income and age (yen/g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
Age	< 35	2.03	2.25	2.40	2.58	2.75
	35–44	2.23	2.26	2.36	2.51	2.82
	45–54	2.44	2.51	2.53	2.66	2.92
	55–64	2.79	2.99	3.04	3.04	3.37
	> 64	3.00	3.28	3.42	3.37	3.75

Table A.19 Price of poultry by income and age (yen/g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
Age	< 35	0.93	0.98	1.00	1.04	1.09
	35–44	0.95	0.96	0.99	1.03	1.12
	45–54	0.98	0.99	0.98	1.02	1.13
	55–64	1.02	1.04	1.06	1.05	1.15
	> 64	1.04	1.09	1.11	1.12	1.22

Table A.20 Price of ground meat by income and age (yen/g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
Age	< 35	1.03	1.06	1.07	1.09	1.14
	35–44	1.04	1.06	1.08	1.12	1.17
	45–54	1.11	1.11	1.13	1.13	1.15
	55–64	1.15	1.16	1.18	1.15	1.18
	> 64	1.18	1.20	1.23	1.22	1.17

Table A.21 Price of ham by income and age (yen/g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
Age	< 35	2.13	2.16	2.24	2.31	2.38
	35–44	2.04	2.10	2.15	2.25	2.36
	45–54	2.11	2.17	2.20	2.26	2.34
	55–64	2.30	2.35	2.33	2.37	2.46
	> 64	2.32	2.42	2.52	2.47	2.53

Table A.22 Price of sausage by income and age (yen/g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
Age	< 35	1.37	1.44	1.50	1.54	1.60
	35–44	1.39	1.42	1.45	1.48	1.53
	45–54	1.46	1.44	1.46	1.50	1.55
	55–64	1.49	1.55	1.56	1.54	1.61
	> 64	1.53	1.57	1.58	1.58	1.61

Table A.23 Price of bacon by income and age (yen/g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
Age	< 35	1.86	1.91	1.97	2.02	2.18
	35–44	1.84	1.90	1.93	2.00	2.06
	45–54	1.83	1.89	1.91	1.97	2.04
	55–64	1.92	2.02	1.97	2.00	2.05
	> 64	1.98	1.98	2.04	2.00	2.11

ANNEX B. DAILY CONSUMPTION OF RICE AND MEATS BY INCOME AND HOUSEHOLD SIZE, 1997

Table B.1 Distibution of sample by income and household size

		Income level (10 000 yen)					
		< 402	402–568	568–745	745–999	999 <	Total
	2	12 122	8 018	5 289	4 017	3 532	32 978
No.	3	4 280	4 640	4 484	4 522	4 801	22 727
family	4	2 750	4 515	5 453	5 607	5 685	24 010
members	5	781	1 670	2 406	2 666	2 699	10 222
	6 or more	378	706	1 113	1 343	1 748	5 288
	Total	20 311	19 549	18 745	18 155	18 465	95 225

Table B.2 Annual total household income by income and household size (10 000 yen)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
	2	289.90	479.36	644.91	857.63	1 454.32
No.	3	301.95	485.11	651.24	856.96	1 349.14
family	4	322.24	489.48	654.40	861.10	1 394.40
members	5	308.80	491.81	658.11	855.30	1 399.76
	6 or more	319.40	491.45	653.66	872.09	1 476.72

Table B.3 Average age of household head by income and household size

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
	2	64.03	59.66	54.90	53.90	57.18
No.	3	49.18	46.95	48.96	51.14	54.29
family	4	43.52	40.58	43.08	46.36	50.36
members	5	45.25	42.31	43.79	46.36	48.87
	6 or more	47.56	43.15	47.67	49.01	52.36

Table B.4 Monthly household total expenditure by income and household size (yen)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
	2	194 837	260 932	361 632	486 851	486 851
No.	3	216 452	260 223	367 136	478 987	478 987
family	4	234 429	274 253	389 926	495 199	495 199
members	5	253 331	294 450	405 363	493 451	493 451
	6 or more	272 545	311 026	350 481	394 010	491 679

Table B.5 Monthly household food expenditure by income and household size (yen)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
	2	58 685	71 371	75 938	82 435	97 312
No.	3	64 233	70 648	79 761	88 004	103 032
family	4	70 773	73 982	86 883	97 690	111 273
members	5	79 760	86 255	94 597	106 326	119 786
	6 or more	88 951	95 659	106 354	115 053	132 258

Table B.6 Daily consumption of non-glutinous rice by income and household size (g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
	2	237.41	227.74	203.27	212.15	198.32
No.	3	260.50	245.94	244.84	265.19	277.61
family	4	266.28	229.46	260.68	295.57	327.77
members	5	357.70	289.98	332.88	386.24	403.10
	6 or more	342.67	422.88	422.51	462.61	453.94

Table B.7 Daily per capita consumption of non-glutinous rice by income (g)
and Houaehold Size, 1997

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
	2	118.71	113.87	101.63	106.08	99.16
No.	3	86.83	81.98	81.61	88.40	92.54
family	4	66.57	57.37	65.17	73.89	81.94
members	5	71.54	58.00	66.58	77.25	80.62
	6 or more	55.52	66.85	66.95	73.49	71.12

Table B.8 Daily household consumption of pork by income and household size (g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
	2	22.70	24.79	25.13	28.16	24.97
No.	3	36.31	34.56	40.31	40.01	40.25
family	4	44.26	46.76	51.36	55.52	56.54
members	5	59.56	56.00	60.43	63.16	70.58
	6 or more	67.34	72.51	72.79	74.12	77.63

Table B.9 Daily household consumption of beef by income and household size (g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
	2	16.26	25.12	30.31	39.18	41.16
No.	3	19.49	25.43	30.24	38.32	45.44
family	4	20.77	28.69	34.81	41.19	39.75
members	5	23.68	31.85	40.08	45.56	48.62
	6 or more	40.96	44.93	43.52	47.93	56.67

Table B.10 Daily household consumption of poultry by income and household size (g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
	2	19.05	20.86	20.51	23.02	19.51
No.	3	28.52	27.88	30.82	30.59	31.29
family	4	35.56	37.58	39.57	42.40	42.46
members	5	48.41	47.18	49.14	48.69	50.28
	6 or more	47.13	53.84	55.73	55.27	60.92

Table B.11 Daily household consumption of ground meat by income and household size (g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
No. household members	2	1.71	1.88	2.48	2.57	2.02
	3	4.71	4.64	4.79	4.15	4.21
	4	6.04	6.55	7.18	7.42	6.98
	5	9.61	9.72	8.40	9.31	9.49
	6 or more	9.99	10.75	8.87	9.70	10.89

Table B.12 Daily household consumption of ham by income and household size (g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
No. household members	2	4.83	5.92	6.50	7.28	7.61
	3	6.38	6.66	8.55	8.66	9.66
	4	7.26	8.88	9.65	10.91	10.92
	5	8.03	9.84	10.99	11.60	12.77
	6 or more	11.00	11.73	12.03	13.55	14.60

Table B.13 Daily household consumption of sausage by income and household size (g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
No. household members	2	5.36	6.69	7.38	7.35	7.33
	3	10.54	12.20	12.05	12.01	11.15
	4	16.62	18.21	19.49	19.35	16.12
	5	18.96	22.34	22.06	21.14	21.19
	6 or more	22.09	26.02	24.42	25.59	24.70

Table B.14 Daily household consumption of bacon by income and household size (g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
No. household members	2	1.74	2.30	2.40	2.50	2.50
	3	3.25	3.05	3.67	3.65	3.57
	4	3.89	4.34	4.61	5.15	4.96
	5	5.01	4.82	5.24	5.93	6.25
	6 or more	5.92	6.27	5.40	6.74	6.91

Table B.15 Price of non-glutinous rice by income and household size (yen/100g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
No. household members	2	48.88	49.83	50.62	50.63	53.73
	3	47.07	47.28	47.77	49.22	49.99
	4	45.61	45.34	46.79	47.55	49.61
	5	45.65	44.96	45.68	46.53	48.82
	6 or more	44.68	45.89	44.98	46.10	46.86

Table B.16 Price of pork by income and household size (yen/g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
No. household members	2	1.53	1.58	1.59	1.61	1.72
	3	1.44	1.47	1.51	1.56	1.64
	4	1.35	1.37	1.44	1.47	1.57
	5	1.35	1.36	1.35	1.44	1.51
	6 or more	1.32	1.36	1.37	1.40	1.49

Table B.17 Price of beef by income and household size (yen/g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
No. household members	2	2.90	3.11	3.15	3.25	3.81
	3	2.48	2.58	2.72	2.91	3.26
	4	2.21	2.25	2.44	2.57	2.94
	5	2.09	2.24	2.27	2.45	2.76
	6 or more	2.00	2.25	2.33	2.34	2.67

Table B.18 Price of poultry by income and household size (yen/g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
No. household members	2	1.03	1.07	1.08	1.08	1.17
	3	1.00	1.02	1.03	1.07	1.10
	4	0.95	0.96	1.00	1.02	1.08
	5	0.90	0.93	0.96	1.01	1.03
	6 or more	0.90	0.97	0.94	0.98	1.00

Table B.19 Price of ground meat by income and household size (yen/g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
No. household members	2	1.15	1.15	1.15	1.17	1.23
	3	1.10	1.11	1.15	1.16	1.21
	4	1.08	1.06	1.11	1.13	1.14
	5	1.02	1.06	1.06	1.11	1.14
	6 or more	1.00	1.05	1.09	1.08	1.09

Table B.20 Price of ham by income and household size (yen/g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
No. household members	2	2.30	2.39	2.44	2.47	2.68
	3	2.18	2.23	2.29	2.37	2.44
	4	2.12	2.11	2.19	2.24	2.37
	5	1.97	2.07	2.07	2.23	2.24
	6 or more	2.02	2.02	2.05	2.09	2.18

Table B.21 Price of sausage by income and household size (yen/g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
No. household members	2	1.51	1.54	1.58	1.58	1.67
	3	1.44	1.48	1.53	1.53	1.61
	4	1.40	1.43	1.47	1.49	1.56
	5	1.34	1.40	1.41	1.50	1.51
	6 or more	1.35	1.38	1.40	1.43	1.47

ANNEX C. DAILY CONSUMPTION OF RICE AND MEATS BY INCOME LEVEL AND NUMBER OF WAGE EARNERS, 1997

Table C.1 Distribution of sample by income and number of wage earners

		Income level (10 000 yen)					
		< 402	402–568	568–745	745–999	> 999	Total
No. wage earners	0	7 555	3 018	921	215	112	11 821
	1	7 647	9 659	8 602	7 447	5 427	38 782
	2	4 231	5 756	7 239	7 600	8 079	32 905
	3	714	875	1 590	2 243	3 361	8 783
	4 or more	164	241	393	650	1 486	2 934
	Sum	20 311	19 549	18 745	18 155	18 465	95 225

Table C.2 Annual total household income by income and number of wage earners (10 000 yen)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
No. wage earners	0	290.00	465.67	632.70	829.50	1 183.27
	1	303.23	486.93	649.57	853.22	1 348.58
	2	300.84	489.64	653.97	862.11	1 388.28
	3	311.51	489.85	661.04	869.58	1 467.55
	4 or more	302.12	485.85	648.91	869.44	1 548.25

Table C.3 Household size by income and number of wage earners

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
No. wage earners	0	2.12	2.13	2.16	2.24	2.22
	1	2.88	3.23	3.44	3.45	3.34
	2	3.01	3.25	3.44	3.60	3.63
	3	3.84	3.80	4.04	4.03	4.06
	4 or more	4.85	4.90	5.05	5.00	5.00

Table C.4 Age of household head by income and number of wage earners

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
No. wage earners	0	69.91	69.69	68.13	65.88	66.23
	1	47.71	45.17	45.06	48.40	51.70
	2	51.26	47.46	47.47	48.21	51.27
	3	56.93	54.47	54.57	53.32	55.41
	4 or more	56.04	54.19	57.30	56.26	56.47

Table C.5 Monthly household total expenditure by income and number of wage earners (yen)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
No. wage earners	0	204 235	294 307	349 280	401 209	422 554
	1	206 270	266 391	319 664	384 870	502 488
	2	215 504	257 700	311 274	389 574	497 661
	3	230 120	271 854		356 111	473 171
	4 or more	227 623	276 662	270 437	303 264	430 959

Table C.6 Monthly household food expenditure by income and number of wage earners (yen)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
	0	62 844	59 405	66 089	76 559	82 305
No.	1	80 510	70 786	73 562	83 638	92 771
wage	2	86 839	82 781	83 823	89 879	94 808
earners	3	102 437	93 123	94 305	95 941	103 694
	4 or more	86 263	109 795	109 055	110 625	112 421

Table C.7 Daily household consumption of non-glutinous rice by income and number of wage earners (g)

		Income level (10 000 yen)				
		< 402	402–68	568–745	745–999	> 999
	0	274.91	273.51	255.45	265.47	156.39
No.	1	221.45	214.96	233.68	269.98	269.40
wage	2	252.64	253.32	263.06	287.97	301.28
earners	3	330.86	374.33	355.71	352.70	354.70
	4 or more	356.62	409.39	382.69	480.56	452.48

Table C.8 Daily per capita consumption of non-glutinous rice by income and number of wage earners (g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
	0	130.67	129.42	120.67	113.76	67.39
No.	1	82.65	73.49	72.88	83.07	86.09
wage	2	88.30	84.19	79.86	83.29	85.54
earners	3	91.27	103.93	92.00	91.56	89.83
	4 or more	76.31	84.85	79.19	97.39	90.52

Table C.9 Daily household consumption of pork by income and number of wage earners (g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
	0	23.17	24.18	23.66	35.20	23.18
No.	1	31.96	36.49	42.18	47.37	47.03
wage	2	37.43	40.07	44.69	46.36	48.11
earners	3	48.55	48.78	55.21	53.58	51.67
	4 or more	71.39	67.19	61.69	62.23	73.30

Table C.10 Daily household consumption of beef by income and number of wage earners (g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
	0	16.35	19.56	19.30	26.99	14.84
No.	1	22.11	24.93	28.75	34.53	37.94
wage	2	26.10	28.78	32.86	36.16	39.63
earners	3	31.52	36.07	36.51	38.01	40.78
	4 or more	51.85	39.44	37.90	41.06	47.25

Table C.11 Daily household consumption of poultry by income and number of wage earners (g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
	0	19.34	20.06	19.51	25.66	11.40
No.	1	26.56	30.51	33.60	35.72	36.72
wage	2	29.38	31.76	35.01	36.21	36.21
earners	3	34.54	38.14	39.03	42.03	40.14
	4 or more	49.84	48.25	51.55	48.55	50.32

Table C.12 Dialy per capita consumption of non-glutinous rice by income and number of wage earners (g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
	0	130.67	129.42	120.67	113.76	67.39
No.	1	82.65	73.49	72.88	83.07	86.09
wage	2	88.30	84.19	79.86	83.29	85.54
earners	3	91.27	103.93	92.00	91.56	89.83
	4 or more	76.31	84.85	79.19	97.39	90.52

Table C.12 Daily household consumption of ground meat by income and number of wage earners (g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
	0	1.62	1.49	1.37	2.91	1.02
No.	1	4.35	5.33	5.84	6.13	6.38
wage	2	4.54	4.88	5.72	6.06	5.70
earners	3	4.24	4.75	5.18	5.13	5.59
	4 or more	7.48	7.48	6.58	7.24	8.06

Table C.13 Daily household consumption of ham by income and number of wage earners (g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
	0	5.30	6.31	7.10	9.13	7.86
No.	1	5.46	7.30	8.54	9.71	10.44
wage	2	6.41	7.52	9.17	9.57	10.68
earners	3	8.00	8.52	9.35	10.74	10.64
	4 or more	9.50	11.74	9.89	11.56	10.61

Table C.14 Daily household consumption of sausage by income and number of wage earners (g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
	0	5.24	5.89	5.68	9.82	6.84
No.	1	10.74	13.92	15.33	15.65	13.77
wage	2	11.04	13.92	15.59	15.74	14.84
earners	3	10.47	13.34	15.02	14.50	14.50
	4 or more	18.28	17.00	14.63	18.81	18.32

Table C.15 Daily household consumption of bacon by income and number of wage earners (g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
No. wage earners	0	1.74	2.24	2.18	2.39	1.73
	1	2.92	3.46	4.04	4.30	4.73
	2	3.02	3.54	3.94	4.52	4.30
	3	3.62	3.46	3.88	4.61	4.40
	4 or more	6.20	4.72	3.60	4.67	5.22

Table C.16 Price of non-glutinous rice by income and number of wage earners (yen/100 g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
No. wage earners	0	48.82	49.87	51.71	46.92	54.43
	1	47.22	47.33	47.91	49.03	51.44
	2	47.12	47.33	47.26	48.02	49.56
	3	47.68	46.35	47.31	47.60	49.61
	4 or more	45.86	45.26	46.99	46.95	48.25

Table C.17 Price of pork by income and number of wage earners (yen/g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
No. wage earners	0	1.55	1.62	1.65	1.68	1.63
	1	1.42	1.44	1.47	1.53	1.65
	2	1.43	1.45	1.47	1.50	1.59
	3	1.45	1.47	1.47	1.48	1.58
	4 or more	1.36	1.45	1.48	1.48	1.51

Table C.18 Price of beef by income and number of wage earners (yen/g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
No. wage earners	0	2.98	3.32	3.56	3.16	3.29
	1	2.43	2.53	2.65	2.83	3.28
	2	2.53	2.54	2.57	2.70	3.06
	3	2.64	2.70	2.66	2.68	3.11
	4 or more	1.98	2.59	2.69	2.66	2.85

Table C.19 Price of poultry by income and number of wage earners (yen/g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
No. wage earners	0	1.03	1.07	1.12	1.11	1.08
	1	0.98	1.01	1.02	1.06	1.12
	2	0.99	1.00	1.00	1.02	1.08
	3	0.98	0.99	1.01	1.02	1.07
	4 or more	0.99	1.00	1.01	1.03	1.02

Table C.20 Price of ground meat by income and number of wage earners (yen/g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
	0	1.16	1.19	1.21	1.31	1.11
No.	1	1.07	1.09	1.11	1.15	1.18
wage	2	1.11	1.08	1.12	1.12	1.17
earners	3	1.13	1.14	1.15	1.14	1.14
	4 or more	1.05	1.06	1.15	1.10	1.12

Table C.21 Price of ham by income and number of wage earners (yen/g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
	0	2.33	2.47	2.56	2.52	2.30
No.	1	2.18	2.20	2.27	2.36	2.50
wage	2	2.15	2.17	2.19	2.27	2.38
earners	3	2.12	2.31	2.24	2.18	2.32
	4 or more	2.03	2.12	2.16	2.22	2.23

Table C.22 Price of sausage by income and number of wage earners (yen/g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
	0	1.50	1.60	1.66	1.51	1.69
No.	1	1.44	1.47	1.50	1.54	1.60
wage	2	1.44	1.45	1.47	1.50	1.56
earners	3	1.46	1.46	1.48	1.47	1.57
	4 or more	1.44	1.42	1.47	1.53	1.50

Table C.23 Price of bacon by income and number of wage earners (yen/g)

		Income level (10 000 yen)				
		< 402	402–568	568–745	745–999	> 999
	0	1.97	2.02	2.01	1.91	1.99
No.	1	1.90	1.93	1.97	2.03	2.11
wage	2	1.84	1.91	1.92	1.97	2.07
earners	3	1.88	1.94	1.93	1.91	2.00
	4 or more	1.66	1.91	1.95	1.98	1.94

The objectives of this research are to analyse food consumption patterns in Japan and to conduct an econometric analysis of Japan's food demand structure. Two specific food demand studies were undertaken for this report: the demand for 11 aggregate food groups, including rice, and the demand for seven meats. The basic conclusion of the paper suggests that rice is consumed in Japan as a normal good, contrary to the results of previous studies. In addition, Marshallian uncompensated and Hicksian compensated own-price elasticities for rice are highly elastic, while the own-price elasticity for meat is relatively price-inelastic. Results from the meat model show that meat expenditure and price elasticities are very similar to those of European and North American nations. This paper makes a significant contribution to the literature on consumption patterns.

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