DYNAMIC ESTIMATION OF THE CONSUMER DEMAND SYSTEM IN POSTWAR JAPAN

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FOREWORD

Understanding the nature and dimensions of the world food problem and the policies available to alleviate it has been the focal point of the IIASA Food and Agriculture Program since it began in 1977.

National food systems are highly interdependent, and yet the major policy options exist at the national level. Therefore, to explore these options it is necessary both to develop policy models for national economies and to link them together by trade and capital transfers. For greater realism the models in this scheme are being kept descriptive, rather than normative. Eventually it is proposed to link models of twenty countries, which together account for nearly 80 percent of important agricultural attributes such as area, production, population, exports, imports, and so on.

A description of consumer behavior is critically important in our policy models. This report on consumer demand estimation for Japan in the postwar period discusses the dynamic aspects of the demand structure over the period 1951–80 and focuses on the specification of a proxy variable for changing tastes. Drs. Sasaki and Fukagawa report important findings with regard to the empirical implementation of their dynamic version of the linear expenditure system and on the varied structures of Japanese consumer demand. This is a further step toward the completion of a detailed agricultural policy model for Japan.

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SUMMARY

This report explores the dynamic demand relations operative in Japan in the period 1951–80 in order to elucidate the dynamic nature and characteristics of the varied structures of consumer demand. The analysis was conducted at the subgroup level on the basis of time series of family budget data, using Powell's version of the linear expenditure system. A taste variable was incorporated into the expenditure functions and five alternative specifications of the taste variable were utilized to take account of recent structural changes in demand. The first two are based on current annual increase in income and on current annual rate of increase in income. The next two incorporate lagged annual increase in income and lagged annual rate of increase in income, and the last specification is based on the time trend.

The analysis was based on a 21-commodity breakdown and numerous individual segments of the total observation period were chosen for estimating the dynamic model. The taste variables had the effect of stabilizing the demand system as a whole and they considerably reduced the instability of important estimates, such as those for money flexibility, subsistence consumption levels, etc. Consumption patterns in Japan are considered to have changed substantially toward more "Westernized" living and eating habits since the beginning of the 1960s. Per capita consumption of rice and fish went down with the increase in deflated income, whereas the consumption of animal protein food, fruit, beverages, and food away from home all increased rapidly. Owing to income and taste effects, transportation, recreation, and rent showed a notable upward shift in average shares, while rice consumption declined remarkably in terms of its reduced marginal share.

Broadly speaking, estimated average substitution elasticity in Leser's model is inversely proportional to estimated money flexibility, which itself has a close relation to price elasticities. High values of money flexibility were obtained for the lower levels of per capita income in the early years of the period studied. For periods of more rapid economic growth, money flexibility estimates dropped to some extent, while for recent years they rose appreciably, reflecting the smaller response of consumer demand to price changes.

CONTENTS

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Kozo Sasaki and Yoshihiro Fukagawa

1 INTRODUCTION

This report explores the dynamic demand relations operative in Japan in the period 1951–80. Consumption levels and patterns have shifted so drastically over the last thirty years that it is of great interest to elucidate the dynamic nature and characteristics of the varied structures of consumer demand during the entire period. Special attention is given to the analysis of structural change in more recent years.

This study also aims at evaluating empirical evidence of the dynamic structure of consumer demand in the postwar period. It is an extension of a previous study (Sasaki 1982) in which both static and dynamic models of the linear expenditure system were fitted to time series of family budget data for the period 1951–77.

The same method is adopted here: a simplified version of the linear expenditure system extended by A. A. Powell for the sake of computational convenience. The expenditure and price data used in the earlier study were updated, adding three more years to the time series. Five alternative specifications of the taste variable were utilized here in order to take due account of recent structural changes in consumer demand. The first two are based on current annual increase in income and on current annual rate of increase in income, which can be seen in some of the conventional demand analyses in econometric models. The next two incorporate lagged annual increase in income and lagged annual rate of increase in income, and the last specification is based on the time trend.

The commodity definition used is described in more detail below. With respect to the previous study, the original 24 subgroups have been adjusted somewhat, yielding a 21-commodity breakdown for all the cases under consideration. Moreover, many individual segments of the total observation period were chosen for estimating the dynamic model. All these changes were made to satisfy more closely the theoretical constraints imposed on the model and to obtain, as far as possible, a good fit between the model and the empirical data.

We also felt it was of some interest to examine the stability of such important parameters as money flexibility, subsistence consumption levels, etc., when a particular specification of the taste variable is introduced into the expenditure functions.

The estimation results for many different cases could, in principle, be compared in various respects. However, this study concentrates on just four subperiods with fairly good results for detailed discussion. Note that most of the statistical tests used are implemented under linear least-squares postulates.

2 METHOD

A complete set of linear expenditure functions is used, explaining per capita expenditure on each commodity in terms of all prices, per capita income, and the taste variable. Under the given assumptions, the estimating equation of Powell's system takes the form:

$$p_{it} x_{it} = p_{it} \bar{x}_{it} + \lambda z_{it} + b_i u_t + c_i s_t + \varepsilon_{it} \qquad (1)$$

where

$$z_{it} = b_i \sum_j b_j (p_{jt}/\bar{p}_j - p_{it}/\bar{p}_i)$$

and

$$u_t = m_t - \sum_j p_{jt} \bar{x}_j \qquad (i, j = 1, 2, \ldots, N), \ (t = 1, 2, \ldots, T)$$

The notation used here is as follows: p_i and x_i are the price and quantity consumed per capita, m the per capita income, s the taste variable, and ε_i the error term. $\bar{p}_i$ is the sample mean of p_i and $\bar{x}_i$ is the ratio of the sample mean expenditure to the mean price $\bar{p}_i$. z_i and u indicate substitution and income variables, respectively. The subscripts i and j are commodity indices, and t denotes time. The λ, b_i, and c_i are unknown parameters. More specifically, λ has the following properties:

$$(\lambda/m) = -(1/\breve{\omega}) = -\varphi \qquad (2)$$

and

$$\lambda = m - \sum_i p_i \beta_i \qquad (\beta_i = \text{subsistence consumption level}) \qquad (3)$$

where $\breve{\omega}$ is money flexibility, which is equivalent to the income elasticity of the marginal utility of income. φ is called income flexibility and is the reciprocal of $\breve{\omega}$. Then λ is interpreted as the supernumerary income. b_i represents the marginal budget share and c_i denotes the coefficient of the taste variable s_t.

The taste variable s_t can be specified in an appropriate way as the occasion requires. Leser (1960) noted that it is easy to estimate a set of regression equations with the same independent variables, but disregarding the z_{it} variable, under least-squares assumptions.[1] In accordance with Leser's argument, Powell's version of the linear expenditure system (Powell 1966) also contains a dynamic factor common to all equations, which allows for shifts in expenditure and demand functions.

In the present analysis, taste changes are represented by a single variable s_t in order to facilitate estimation by a systems least-squares method. The dynamic model is fitted for various phases of the period studied, with alternative specifications of a proxy for the taste variable. In the first place, two alternative expressions are taken into account: current annual increase in income and current annual *rate* of increase in income:

$$s_t = m_t - m_{t-1} \quad \text{and} \quad s_t = (m_t - m_{t-1})/m_{t-1} \tag{4}$$

These expressions are applied uniformly to all cases involving different sample periods. For more recent periods, which the above specifications do not fit well, three different alternative expressions are incorporated separately into the estimating equation (1). These are written as:

$$s_t = m_{t-1} - m_{t-2} \quad \text{and} \quad s_t = (m_{t-1} - m_{t-2})/m_{t-2} \tag{5}$$

and

$$s_t = t \qquad (t = 1, 2, \ldots, T) \tag{6}$$

Equation (5) is the same as eqn. (4), except that the former has a one-year lag. It simply suggests that, in recent years, the consumer has responded more slowly to either annual increments in or the annual growth rate of real income.

The dynamic model is assumed to satisfy the homogeneity condition only at the mid-point of the sample period. In cases where the model uses deflated expenditure and price data, however, all current (or nominal) expenditure functions are homogeneous of degree one in current prices, current income, and the General Consumer Price Index (hereafter referred to as the CPI). It is apparent that the corresponding demand functions are homogeneous of degree zero in current prices and income.

3 DATA AND ESTIMATION

The data sources on per capita expenditures and prices are the Annual Reports published by the Office of the Prime Minister, Japan (1950–1980). Data for all households in cities with a population of 50,000 or more are utilized in this study, since long time series are available on expenditures and prices in the postwar period. Price indexes in the Laspeyres form are available for all subgroups and these are taken as individual prices for each subgroup, with all of the 1970 indexes being set at unity. Hence, the associated quantities represent expenditures in constant 1970 yen.

The commodity grouping on which the study is based is shown in Table 1. In practice, a 21- rather than 24-commodity breakdown is generally employed here by combining several of the original subgroups into broader groups. This results in two commodity lists, which differ slightly from each other as can be seen in some of the following tables. All the time series used cover the period 1951–80.

It should be noted that both the expenditure and the price data are deflated by the CPI so as to ensure that consumer demand in the model does not respond to changes in nominal prices, but to changes in relative prices.

TABLE 1 The 24 commodity groups employed in the study.

No.	Commodity	No.	Commodity
1	Rice	13	Repairs
2	Other cereals	14	Water charges
3	Fish	15	Furniture
4	Meat	16	Fuel + light
5	Milk + eggs	17	Clothes
6	Vegetables	18	Personal effects
7	Processed food	19	Medical care
8	Cakes	20	Toiletries
9	Fruit	21	Transportation
10	Beverages	22	Education
11	Food away from home (f.a.f.h.)	23	Tobacco
12	Rent	24	Recreation

This analysis takes into account the changes in prices and income relative to the CPI. Given the values of the taste variable, current (or nominal) expenditure functions are homogeneous of degree one in current prices. It follows immediately that the demand functions are homogeneous of degree zero in all current prices.

We begin each analysis with the estimation of Leser's dynamic model,[2] and the nonlinear estimation of Powell's dynamic model is then undertaken by an iterative procedure. The estimation criterion is to minimize the sum of squared residuals over all commodities and all observed years under the assumption of a simple error structure.[3] The criterion of convergence for estimated parameters must be determined so that the iterative regression terminates when the relative deviation of the parameter $\hat{\lambda}$ between two successive rounds is reduced to below 0.01 percent. This convergence is generally fast, and it is usually reached within 20 rounds. However, convergence is not always achieved.[4]

As the sample period becomes longer, the assumed linearity of expenditure functions tends to become unacceptably rigid. In particular, Engel curves would not remain linear for some commodities, as has been frequently pointed out in the literature.[5] As a matter of fact, a few commodities change from being normal goods to inferior goods and *vice versa*. A few others actually remain rather irresponsive to income changes. Therefore, sample periods need to be chosen carefully in accordance with particular phases of demand structure development.

4 ESTIMATION RESULTS

First of all, the dynamic models were applied to numerous sample periods using two related descriptions for the proxy of the taste variable: namely, the current annual increase in deflated income and its current annual rate of increase. The whole period studied can be roughly divided into two parts as regards the estimation of dynamic demand models. The first is the 1950s, which represented an early stage of the postwar period. The second part consists of the 1960s and 1970s, which can be designated as a

TABLE 2 Estimates of the demand parameters $\hat{b}_i$, $\hat{c}_i$, and $\hat{\lambda}$ for the period 1951–61. Taste variable: $s_t = m_t - m_{t-1}$.

i	Commodity group	Marginal budget share		Coefficient of s_t variable		Multiple correlation coefficient		Serial correlation coefficient
		$\hat{b}_i$	$\lvert t \rvert$ ratio	$\hat{c}_i$	$\lvert t \rvert$ ratio	$R_{y'.us}$	R	
1	Rice	.0284	3.354	.0192*	.377	.793	.918	.324
2	Other cereals	–.0351	8.753	–.0129*	.538	.958	.948	.450
3	Fish	.0084	3.230	.0129*	.827	.801	.912	.169
4	Meat	.0365	19.893	.0038*	.348	.991	.992	.245
5	Milk + eggs	.0494	26.856	–.0129*	1.169	.995	.993	.274
6	Vegetables	–.0057*	2.285	.0217*	1.459	.649*	.933	–.101
7	Processed food	.0526	14.527	–.0057*	.265	.983	.972	.261
8+9	Cakes + fruit	.0353	12.910	.0221*	1.343	.981	.958	–.017
10	Beverages	.0366	17.555	.0095*	.759	.989	.983	.078
11	F.a.f.h.	.0490	18.433	–.0033*	.206	.990	.989	.469
12	Rent	.0175	3.854	.0126*	.461	.832	.965	.084
13	Repairs	.0237	7.728	–.0103*	.559	.943	.943	.121
14	Water charges	.0045	8.287	.0025*	.775	.954	.973	.230
15	Furniture	.0932	10.549	.0093*	.175	.970	.966	.470
16	Fuel + light	.0363	12.521	.0095*	.546	.978	.985	.401
17+18	Clothes + personal effects	.1496	19.643	.1514	3.313	.992	.982	–.099
19	Medical care	.0372	20.582	–.0142*	1.312	.991	.981	.342
20	Toiletries	.0264	11.949	–.0066*	.495	.975	.979	.432
21	Transportation	.0233	15.466	–.0019*	.215	.985	.989	.188
22	Education	.0314	8.886	–.0355*	1.675	.954	.975	.327
23+24	Tobacco + recreation	.3013	41.600	–.1709	3.932	.998	.998	.387
$\hat{\lambda}$		30,799	2.534	($\hat{\varphi}$ = –.2580)				

* Insignificant at the 5-percent level ($\hat{b}_i$, $\hat{c}_i$, $R_{y'.us}$).
All serial correlation coefficients are insignificant at the 5-percent level.

TABLE 3 Demand elasticities $(\bar{e}_{ij}, \bar{E}_j)$ estimated for 21 subgroups[a] at the sample 1951–61.

i \ j	1	2	3	4	5	6	7	8+9	10	11
Price elasticities $\bar{e}_{ij}$										
1	−.087	−.010	−.010	−.004	−.003	−.009	−.015	−.008	−.004	−.002
2	.124	.326	.047	.018	.014	.040	.068	.037	.018	.009
3	−.021	−.008	−.055	−.003	−.002	−.007	−.011	−.006	−.003	−.002
4	−.161	−.058	−.061	−.386	−.018	−.052	−.088	−.048	−.023	−.012
5	−.219	−.079	−.083	−.032	−.578	−.071	−.120	−.065	−.031	−.016
6	.018	.007	.007	.003	.002	.047	.010	.005	.003	.001
7	−.079	−.028	−.030	−.011	−.009	−.026	−.221	−.023	−.011	−.006
8+9	−.094	−.034	−.036	−.014	−.011	−.030	−.051	−.239	−.013	−.007
10	−.162	−.058	−.062	−.023	−.019	−.052	−.089	−.048	−.388	−.012
11	−.264	−.096	−.101	−.038	−.030	−.086	−.145	−.079	−.038	−.616
12	−.091	−.033	−.035	−.013	−.010	−.029	−.050	−.027	−.013	−.007
13	−.192	−.069	−.073	−.028	−.022	−.062	−.105	−.057	−.028	−.014
14	−.114	−.041	−.043	−.017	−.013	−.037	−.062	−.034	−.016	−.009
15	−.337	−.122	−.128	−.049	−.039	−.109	−.185	−.100	−.048	−.025
16	−.081	−.029	−.031	−.012	−.009	−.026	−.044	−.024	−.012	−.006
17+18	−.138	−.050	−.053	−.020	−.016	−.045	−.076	−.041	−.020	−.010
19	−.194	−.070	−.074	−.028	−.022	−.063	−.106	−.058	−.028	−.015
20	−.091	−.033	−.035	−.013	−.010	−.029	−.050	−.027	−.013	−.007
21	−.141	−.051	−.054	−.020	−.016	−.046	−.077	−.042	−.020	−.011
22	−.115	−.041	−.044	−.017	−.013	−.037	−.063	−.034	−.017	−.009
23+24	−.178	−.064	−.068	−.026	−.020	−.058	−.098	−.053	−.026	−.013
Income elasticities $\bar{E}_j$										
	.234	−1.088	.183	1.406	1.913	−.159	.690	.819	1.414	2.312
Budget shares $\bar{w}_j$										
	.122	.032	.046	.026	.026	.036	.076	.043	.026	.021

[a] For a full list of the commodity groups i, j see Table 1.
$\bar{e}_{ij}$ = elasticity of subgroup i with respect to the jth price, calculated at the sample means.
$\bar{E}_j$ = income elasticity of subgroup j, calculated at the sample means.
$\bar{w}_j$ = budget share of subgroup j, calculated at the sample means.

means of all variables and sample mean average budget shares ($\bar{w}_j$), for the period

12	13	14	15	16	17+18	19	20	21	22	23+24
−.004	−.002	−.001	−.002	−.010	−.020	−.003	−.006	−.003	−.005	−.027
.019	.009	.004	.008	.046	.093	.013	.029	.014	.025	.126
−.003	−.001	−.001	−.001	−.008	−.016	−.002	−.005	−.002	−.004	−.021
−.025	−.011	−.005	−.011	−.059	−.120	−.017	−.037	−.018	−.033	−.163
−.034	−.015	−.006	−.015	−.081	−.163	−.024	−.050	−.025	−.044	−.222
.003	.001	.001	.001	.007	.014	.002	.004	.002	.004	.018
−.012	−.006	−.002	−.005	−.029	−.059	−.009	−.018	−.009	−.016	−.080
−.014	−.007	−.003	−.006	−.035	−.070	−.010	−.022	−.011	−.019	−.095
−.025	−.011	−.005	−.013	−.060	−.120	−.017	−.037	−.018	−.033	−.164
−.040	−.019	−.008	−.017	−.098	−.197	−.029	−.061	−.030	−.054	−.268
−.219	−.006	−.003	−.006	−.034	−.068	−.010	−.021	−.010	−.018	−.092
−.029	−.445	−.006	−.011	−.071	−.142	−.021	−.044	−.022	−.039	−.194
−.017	−.008	−.260	−.008	−.042	−.085	−.012	−.026	−.013	−.023	−.115
−.052	−.024	−.010	−.782	−.124	−.250	−.036	−.078	−.038	−.068	−.341
−.012	−.006	−.002	−.005	−.211	−.060	−.009	−.019	−.009	−.016	−.082
−.021	−.010	−.004	−.009	−.051	−.415	−.015	−.032	−.016	−.028	−.140
−.030	−.014	−.006	−.013	−.072	−.144	−.458	−.045	−.022	−.039	−.196
−.014	−.006	−.003	−.006	−.034	−.068	−.010	−.226	−.010	−.018	−.092
−.022	−.010	−.004	−.009	−.052	−.105	−.015	−.032	−.333	−.029	−.143
−.018	−.008	−.003	−.008	−.042	−.085	−.012	−.026	−.013	−.282	−.116
−.027	−.013	−.005	−.012	−.066	−.132	−.019	−.041	−.020	−.036	−.582
.795	1.675	.995	2.945	.704	1.210	1.695	.795	1.230	1.004	1.557
.022	.014	.004	.032	.052	.124	.022	.033	.019	.031	.194

more advanced stage from the viewpoint of economic development or in terms of consumption levels and patterns.

Estimation results for four subperiods 1951–61, 1960–77, 1958–80, and 1960–80 are selected here for detailed discussion. For the more recent years, the specification of the taste variable was modified. The commodity grouping used for earlier subperiods is also different from that of recent subperiods. Great efforts were made to enhance the goodness of fit of the models and to handle as many normal goods as possible.

4.1 The Period 1951–61

For the earlier years studied, five subperiods between 1951 and 1965 were analyzed, with all of the subperiods starting in 1951. Table 2 reports the estimates of demand parameters and relevant coefficients for the subperiod 1951–61. All commodities except other cereals and vegetables were found to be normal goods (f.a.f.h. is an abbreviation for food away from home). Other cereals are identified as an inferior good, while vegetables hardly respond at all to changes in income.

The coefficient of the taste variable is positive for clothes and personal effects, negative for tobacco and recreation, and not statistically significant for the other commodities. The taste variable is proxied by the current annual increase of deflated income. Multiple correlation coefficients[6] are large on the whole, and those values indirectly calculated exceed 0.9. Fortunately, there is no significant first-order serial correlation in the residuals. In connection with the goodness of fit, 231 ($N \times T$) measures of fit were computed for all subgroups and all observation years to conduct the interpolation test within the sample period. Only two of them had values of less than 80 percent. These measures indicate the ratios of estimated to actual expenditures, which are simply the ratios of estimated to actual quantities purchased. Therefore, the fitted system has a high predictive power in this early subperiod.

The income flexibility estimate at the sample mean $\hat{\varphi}$ is derived from the parameter $\hat{\lambda}$ and the sample mean income $\bar{m}$. It yields a value of −3.9 for the money flexibility $\hat{\omega}^e$. Even where the estimated money flexibility was this high, own price elasticities did not come out as low as expected, since there are several subgroups with remarkably large income elasticities.

The estimated expenditure system can be conveniently expressed in elasticity form. The estimates of behavioral parameters in Table 2, together with the observed data, provide a complete set of income and price elasticities, evaluated at the sample means for all variables. Table 3 shows the demand elasticities and sample-mean average budget shares.

Income elasticity is particularly high for furniture, food away from home (f.a.f.h.), milk and eggs, repairs, medical care, and tobacco and recreation. Own price elasticity is higher for these subgroups than for others.[7] One striking feature is that rice proved to be a normal good, with an income elasticity of 0.23 and an own price elasticity of −0.09. Fish and vegetables are also quite inelastic with respect to prices as well as income. As for the average budget shares, rice, clothes and personal effects, and tobacco and recreation account

TABLE 4 Estimated money flexibility $\breve{\omega}^e$ by sample period in the earlier years studied.

Period	Taste variable	
	$s_t = m_t - m_{t-1}$	$s_t = (m_t - m_{t-1})/m_{t-1}$
1951–61	−3.877	−4.623
1951–62	−3.571	−4.012
1951–63	−2.915	−3.075
1951–64	−2.216	−2.303
1951–65	−2.065	−2.068

$\breve{\omega}^e = 1/\hat{\varphi} = -\overline{m}/\hat{\lambda}$, $-\varphi = (m - \sum_i p_i \beta_i)/m$.

The subgroups of cakes and fruit, clothes and personal effects, and tobacco and recreation are further aggregated here into three larger subgroups, respectively.

for 44 percent of the total budget. The Engel coefficient is still as high as 45 percent on the average, as will be illustrated later. This would seem to imply that 1951–61 was a transitional period from a low standard of living to more comfortable living conditions.

Own price elasticities are all less than 1.0 in absolute value for normal goods. This follows from the fact that all estimates of β_{it} are positive in sign.[8] β_{it} represents the subsistence consumption level, although this interpretation does not apply for inferior goods. The β_{it} estimates for most subgroups do not vary significantly within the sample period; nor does the subsistence cost.

Table 4 presents the money flexibility estimates $\breve{\omega}^e$ at sample means, which have been calculated for each sample period and each alternative specification of the taste variable. Most of the estimated money flexibilities lie within the range −2.1 to −4.0. As the sample period is lengthened the absolute value of money flexibility declines substantially. Obviously, it fell with a rise in deflated income in those earlier years. Using the annual increase in income as a proxy for the taste variable generates more stable results as regards the value of money flexibility than does the use of annual *rates* of increase in income.

Turning to the estimates of the average substitution elasticity in Leser's model,[9] many of these were in the region 0.3 to 0.4. This reveals that, on the whole, substitutability between different subgroups of commodities is limited to a considerable extent. Extremely limited substitutability was particularly evident for the subperiods 1951–61 and 1951–62.

After all of the β_{it} values were calculated, the cost of living index[10] and subsistence cost were estimated for every year in the subperiod 1951–61, despite the negative marginal budget shares for both other grains and vegetables. These two subgroups comprise only a small portion of the total budget. The results are summarized in Table 5. The cost of living index, deflated by the CPI, is less than 100 for all years other than the base year, 1951. This would appear to be logical, because the deflator of the Laspeyres Index exceeds the true index of cost of living in value. The subsistence cost is valued in 1970 yen without modification by the cost of living index in Table 5.

TABLE 5 Estimates of the cost-of-living index and the subsistence cost by year for the period 1951–61, deflated by the CPI.

Year	Cost-of-living index	Subsistence cost[a]
1951	100.0	88,454
1952	99.6	88,262
1953	99.0	88,360
1954	98.7	87,860
1955	98.9	88,098
1956	99.2	88,488
1957	99.5	88,960
1958	99.1	88,707
1959	99.3	88,873
1960	99.2	88,938
1961	99.1	89,564

[a] Subsistence cost = $\sum_i p_{it} \hat{\beta}_{it}$ in 1970 yen.

4.2 The Period 1960–77

This subperiod includes the 1960s, which saw a rapid growth of the Japanese economy during which consumer demand expanded greatly as a whole and also became more diversified. It is noticeable that a number of static and dynamic versions of the present expenditure system were fairly well suited for periods of about twenty years up until 1977. Selected results are briefly discussed here. Estimated demand parameters and related results are not, however, tabulated here because they are very similar to those for the period 1958–77 reported previously (Sasaki 1982).

The sign of the marginal budget share of rice changed, and rice is now the only inferior good. Both other cereals and vegetables are now found to be normal goods. (Note that there is little difference between the commodity classification used for this period and that for 1951–61.) Estimates of marginal budget shares for fish and education are not significant: in other words, per capita expenditures in constant prices on neither fish nor education varied significantly with income. The coefficient of the taste variable is significant for toiletries and for tobacco and recreation at the 5-percent level, and is significant for clothes at the 10-percent level. The taste variable is specified in the same form as that for the period 1951–61, namely as a current annual increase in deflated income.

There are two subgroups, fish and education, with low multiple correlation coefficients for their estimating equations. Fortunately, again, there are few problems related to the serial correlation coefficients. Measures of fit computed to attempt the interpolation test were very high. Only one of the 378 ($N \times T$) point estimates failed to reach the 80-percent level. The estimated income flexibility $\hat{\varphi}$ increased, compared with the result in Table 2, and the corresponding money flexibility $\tilde{\omega}^e$ was −2.5.

In the food category, the income elasticities for food away from home, beverages, fruit, and meat, etc., are each greater than 1.0. Apart from other cereals and vegetables, however, most of the income elasticities decreased compared to the earlier period. On the other hand, own price elasticity rose for beverages, cakes, and fruit. Turning to the nonfood category, there are

TABLE 6 Estimates of the demand parameters $\hat{b}_i$, $\hat{c}_i$, and $\hat{\lambda}$ for the period 1958–80. Taste variable: $s_t = m_{t-1} - m_{t-2}$.

i	Commodity group	Marginal budget share		Coefficient of s_t variable		Multiple correlation coefficient		Serial correlation coefficient
		$\hat{b}_i$	$\lvert t \rvert$ ratio	$\hat{c}_i$	$\lvert t \rvert$ ratio	$R_{y'.us}$	R	
1	Rice	–.0546	30.811	.0451*	1.999	.990	.983	.726**
2	Other cereals	.0035	5.838	–.0092*	1.198	.804	.968	.285
3	Fish	–.0048	3.096	.0019*	.094	.571	.982	.603**
4+5	Meat, milk, etc.	.0626	19.950	.0400*	1.001	.976	.965	.793**
6	Vegetables	.0061	5.168	–.0216*	1.427	.773	.971	.522
7	Processed food	.0194	22.073	.0099*	.879	.980	.985	.378
8	Cakes	.0134	16.706	.0212*	2.068	.966	.960	.693**
9	Fruit	.0198	11.520	.0232*	1.057	.932	.906	.667*
10	Beverages	.0406	27.709	.0293*	1.567	.987	.975	.491
11	F.a.f.h.	.0462	27.864	–.0197*	.933	.987	.989	.715**
12	Rent	.0357	27.198	–.0081*	.486	.987	.989	.501
13+14	Repairs + water	.0139	12.373	.0377	2.628	.942	.975	.602**
15	Furniture	.0683	18.648	.1341	2.870	.973	.942	.424
16	Fuel + light	.0525	28.509	–.0450*	1.913	.988	.972	.290
17	Clothes	.0794	22.238	.0832*	1.828	.980	.973	.517
18	Personal effects	.0152	11.911	.0223*	1.369	.936	.944	.580**
19	Medical care	.0397	88.200	–.0008*	.140	.999	.998	–.062
20	Toiletries	.0195	24.745	.0179*	1.783	.984	.983	.467
21	Transportation	.1199	20.754	–.1048*	1.423	.978	.975	.652**
22	Education	.0062	2.700	.0188*	.647	.523	.928	.815**
23+24	Tobacco + recreation	.3973	45.287	–.2755	2.463	.995	.995	.556
$\hat{\lambda}$		87,197	2,742	($\hat{\varphi}$ = –.3733)				

*Insignificant at the 5-percent level ($\hat{b}_i$, $\hat{c}_i$, $R_{y'.us}$).
**Significant at the 5-percent level (serial correlation coefficient).

TABLE 7 Demand elasticities ($\bar{e}_{ij}, \bar{E}_j$) estimated for 21 subgroups[a] at the sample

i \ j	1	2	3	4+5	6	7	8	9	10	11
Price elasticities $\bar{e}_{ij}$										
1	.509	.017	.046	.043	.030	.052	.017	.013	.016	.019
2	−.015	−.084	−.009	−.008	−.006	−.010	−.003	−.002	−.003	−.004
3	.009	.002	.053	.005	.003	.006	.002	.001	.002	.002
4+5	−.070	−.016	−.041	−.425	−.027	−.047	−.015	−.012	−.015	−.017
6	−.014	−.003	−.009	−.008	−.086	−.010	−.003	−.002	−.003	−.003
7	−.025	−.006	−.015	−.014	−.010	−.156	−.005	−.004	−.005	−.006
8	−.047	−.010	−.027	−.026	−.018	−.031	−.267	−.008	−.010	−.011
9	−.071	−.016	−.041	−.039	−.027	−.047	−.015	−.402	−.015	−.017
10	−.094	−.021	−.055	−.052	−.037	−.063	−.020	−.016	−.539	−.023
11	−.093	−.021	−.055	−.051	−.036	−.062	−.020	−.016	−.019	−.537
12	−.078	−.017	−.046	−.043	−.030	−.052	−.017	−.013	−.016	−.019
13+14	−.043	−.010	−.025	−.024	−.017	−.029	−.009	−.007	−.009	−.010
15	−.100	−.022	−.059	−.055	−.039	−.067	−.022	−.017	−.021	−.024
16	−.084	−.019	−.050	−.046	−.033	−.056	−.018	−.014	−.018	−.020
17	−.068	−.015	−.040	−.037	−.026	−.045	−.015	−.012	−.014	−.016
18	−.034	−.008	−.020	−.019	−.013	−.023	−.007	−.006	−.007	−.008
19	−.106	−.023	−.062	−.058	−.041	−.070	−.023	−.018	−.022	−.025
20	−.048	−.011	−.028	−.026	−.018	−.032	−.010	−.008	−.010	−.011
21	−.160	−.036	−.094	−.088	−.062	−.107	−.034	−.027	−.033	−.039
22	−.013	−.003	−.008	−.007	−.005	−.009	−.003	−.002	−.003	−.003
23+24	−.099	−.022	−.058	−.054	−.038	−.066	−.021	−.017	−.020	−.024
Income elasticities $\bar{E}_j$										
	−1.155	.215	−.127	1.016	.215	.372	.689	1.045	1.302	1.378
Budget shares $\tilde{w}_j$										
	.047	.016	.038	.060	.029	.052	.020	.019	.029	.034

[a] For a full list of the commodity groups i, j see Table 1.
[b] $\bar{e}_{ij}$, $\bar{E}_j$, and $\tilde{w}_j$ are as defined in Table 3.

means of all variables and sample mean average budget shares ($\bar{w}_j$).[b]

12	13+14	15	16	17	18	19	20	21	22	23+24
.020	.019	.023	.026	.057	.028	.012	.024	.007	.033	.143
–.004	–.004	–.004	–.005	–.011	–.005	–.002	–.004	–.001	–.006	–.027
.002	.002	.003	.003	.006	.003	.001	.003	.001	.004	.016
–.018	–.017	–.021	–.023	–.051	–.025	–.011	–.021	–.006	–.030	–.128
–.004	–.004	–.004	–.005	–.011	–.005	–.002	–.004	–.001	–.006	–.027
–.007	–.006	–.008	–.008	–.018	–.009	–.004	–.008	–.002	–.011	–.046
–.012	–.011	–.014	–.015	–.034	–.017	–.007	–.014	–.004	–.020	–.085
–.019	–.017	–.021	–.023	–.052	–.025	–.011	–.021	–.006	–.030	–.129
–.025	–.023	–.028	–.031	–.069	–.034	–.015	–.028	–.008	–.040	–.172
–.024	–.023	–.028	–.031	–.068	–.034	–.015	–.028	–.008	–.039	–.170
–.449	–.019	–.023	–.026	–.057	–.028	–.012	–.023	–.007	–.013	–.142
–.011	–.248	–.013	–.014	–.031	–.016	–.007	–.013	–.004	–.018	–.079
–.026	–.025	–.587	–.033	–.074	–.036	–.016	–.030	–.009	–.043	–.184
–.022	–.021	–.025	–.495	–.062	–.030	–.011	–.026	–.007	–.036	–.154
–.018	–.017	–.020	–.023	–.425	–.024	–.011	–.020	–.006	–.029	–.124
–.009	–.008	–.010	–.011	–.025	–.201	–.005	–.010	–.003	–.014	–.062
–.028	–.026	–.032	–.035	–.077	–.038	–.600	–.032	–.009	–.045	–.193
–.012	–.012	–.014	–.016	–.035	–.017	–.007	–.277	–.004	–.020	–.087
–.042	–.040	–.048	–.053	–.117	–.058	–.025	–.048	–.900	–.068	–.293
–.004	–.003	–.004	–.004	–.010	–.005	–.002	–.004	–.001	–.080	–.025
–.026	–.024	–.030	–.033	–.072	–.036	–.015	–.030	–.008	–.042	–.726
1.149	.637	1.492	1.250	1.004	.506	1.563	.704	2.373	.199	1.462
.031	.022	.046	.042	.079	.030	.025	.028	.051	.031	.272

quite a few subgroups whose income elasticities exceed 1.0. Demands for transportation, medical care, furniture, and recreation are all highly responsive to income changes. The absolute values of own price elasticity increased conspicuously for transportation, medical care, recreation, and rent, and for fuel and light. Own price elasticities were all less than 1.0 in absolute value, which stems from the fact that all of the β_{it} estimates were positive.

The average budget shares for rice and other cereals are much smaller than before. Those for food away from home, meat, milk and eggs, and beverages apparently went up. Of the nonfood subgroups, recreation and transportation sharply expanded their shares of the total budget. Money flexibilities are found to be rather stable in the three subperiods 1958–77, 1959–77, and 1960–77, falling in the range −2.1 to −2.7. The estimates for 1958–79, however, fell some distance outside this range. Moreover, the specification of the taste variable used here does not seem to be suitable for more recent years. This issue will be discussed later. Leser's elasticities of substitution were estimated at between 0.6 and 0.7, except for the period 1951–77, for which the values were slightly greater than 1.0.

4.3 The Period 1958–80

The specifications of the taste variable described above did not prove suitable for estimating the dynamic model for more recent years. Moreover, the static model did not fit the latest data sets. Accordingly, another pair of taste variables were implemented separately for the estimation of dynamic expenditure systems: namely, a lagged annual change in deflated income and a lagged annual rate of change in deflated income. For this purpose, a one-year lag was applied to the previous taste variables. The resulting, new taste variables are predetermined variables in the expenditure system, and they produced good results for some cases covering more recent years.

Some examples of the results are shown in Table 6 in terms of estimated demand parameters and related coefficients. The marginal budget share now takes a negative value for fish as well as for rice. The growth of expenditure in constant prices on fish was so low in the past that the income responsiveness of fish consumption turned out to be insignificant for the period 1960–77. Over a longer period of time, such as the present subperiod, 1958–80, the income elasticity of fish declines to a negative value. It is frequently said that the reduction in fish consumption as a whole has been due to the sharp increase in its price associated with changes in fish-supply conditions in recent years, changes in quality, and so on. All subgroups other than rice and fish are normal goods.

The coefficient of the taste variable is significantly different from zero at the 5-percent significance level for three subgroups: repairs and water, furniture, and tobacco and recreation. At the 10-percent level, by comparison, it is significant for five more subgroups as far as the t-ratio test is concerned: these are rice, cakes, fuel and light, clothes, and toiletries.

Multiple correlation coefficients are all significant, but nearly half of all the subgroups have positive serial correlation in the residuals. Measures of fit in the interpolation test were mostly 80 percent or more. Of the 483 ($N \times T$)

TABLE 8 Estimated money flexibility $\breve{\omega}^e$ by sample period in recent years.

Period	Taste variable	
	$s_t = m_{t-1} - m_{t-2}$	$s_t = (m_{t-1} - m_{t-2})/m_{t-2}$
1952–80	−1.320	−1.295
1958–80	−2.679	−2.528
1959–80	−3.225	−3.051
1960–80	−3.050	−2.919
1961–80	−3.083	−2.993

$\breve{\omega}^e = 1/\hat{\varphi} = -\overline{m}/\hat{\lambda}$, $-\varphi = (m - \sum_i p_i \beta_i)/m$.

The subgroups of meat, milk, and eggs, repairs and water charges, and tobacco and recreation are further aggregated here into three larger subgroups, respectively.

TABLE 9 Estimates of the cost-of-living index and the subsistence cost by year for the period 1958–80, deflated by the CPI.

Year	Cost of living index[a]	Subsistence cost[b]	Year	Cost of living index[a]	Subsistence cost[b]
1958	100.0 (99.7)	143,428	1970	98.5 (98.3)	145,936
1959	100.4 (100.1)	143,412	1971	99.0 (98.8)	146,480
1960	100.3 (100.0)	143,209	1972	99.2 (99.0)	146,818
1961	100.0 (99.7)	143,186	1973	99.0 (98.8)	148,103
1962	99.3 (99.1)	143,010	1974	98.0 (97.8)	147,813
1963	98.8 (98.6)	143,077	1975	99.7 (99.4)	149,372
1964	99.0 (98.8)	143,399	1976	99.7 (99.4)	151,064
1965	97.8 (97.5)	143,077	1977	99.2 (98.9)	150,957
1966	98.6 (98.3)	142,983	1978	100.7 (100.4)	152,887
1967	98.5 (98.2)	143,688	1979	100.1 (99.9)	152,491
1968	98.4 (98.2)	144,297	1980	100.3 (100.1)	152,801
1969	99.0 (98.7)	145,475			

[a] Cost of living index in 1958 = 100.0. Figures in parentheses also indicate cost of living indexes but based on 1960 = 100.0.
[b] Subsistence cost = $\sum_i p_{it} \hat{\beta}_{it}$ in 1970 yen.

point estimates for measures of fit, only five estimates were at the 70-percent level and only three fell below 70 percent. The value of income flexibility $\hat{\varphi}$ decreased, and a money flexibility $\breve{\omega}^e$ of −2.7 was obtained.

Income and price elasticities were estimated and these are shown in Table 7. They are similar to the corresponding elasticities for the period 1960–77. Food away from home, beverages, fruit, and meat, etc., are elastic with respect to income within food subgroups. In the nonfood category, transportation, medical care, furniture, and tobacco and recreation have very high income elasticities. Own price elasticities are mostly lower than the corresponding 1960–77 results.

Table 8 reports the estimates of money flexibilities for more recent subperiods. The estimated money flexibility ranges from −2.5 to −3.2, except for the 1952–80 estimates, which are given here only for reference. The longer the sample period, the smaller the absolute value of money flexibility tends to be. Leser's elasticities of substitution were around 0.6 in the four subperiods, while those for the 1952–80 period were close to 1.0.

All β_{it} estimates were found to have positive values and to change, to a greater or lesser extent, from year to year. The cost of living index and subsistence cost by year, computed from estimated demand parameters and observed data, are presented in Table 9. Incidentally, these results for the individual years between 1960 and 1977 were comparable with those obtained for the whole period 1960–77 and examined in Section 4.2.

4.4 The Period 1960–80

For this period, two model formulations were employed. The first, and less successful approach used the lagged annual change in deflated income for the taste variable in the same way as described in earlier sections. The second approach utilized a time trend as a proxy for the taste variable. The results for each method will now be briefly described.

4.4.1 Use of Lagged Changes in Income

The lagged annual change in deflated income was again found to play a role in changes in tastes, although using this kind of taste variable shed little light on the dynamic factors at work. Rice and fish have negative marginal budget shares while all other subgroups have positive ones. Repairs and water, and furniture, have positive coefficients for the taste variable while tobacco and recreation show a negative coefficient at the 5-percent significance level. At the 10-percent level, the coefficient of the taste variable is positive for rice and cakes, but negative for fuel and light. These data are not tabulated here because they are very similar to the results in Table 6 for the period 1958–80.

4.4.2 Use of the Time Trend

Since none of the specifications of the taste variable described earlier worked particularly well in identifying dynamic factors affecting the expenditure system, a time trend mechanism was incorporated in the model. This version of the model has been fitted to four data sets in recent years, and it has been found that the time trend serves rather well as a proxy for the taste variable over relatively long time series.

The period 1960–80 is singled out here for more detailed discussion, and the relevant data are given in the following two tables. Table 10 indicates that the coefficient of the time trend is statistically significant for two-thirds of all subgroups of commodities. The trend variable exerts a significantly positive effect on four subgroups, including food away from home and transportation, and it has a negative coefficient for ten other subgroups. For the remaining subgroups it does not seem to have any significant influence.

Rice is certainly an inferior good. All other commodities are normal goods except other cereals, food away from home, transportation, and education, which are irresponsive to income change. The multiple correlation coefficients, whether or not they are adjusted for degrees of freedom, tend to be greater and the serial correlation in the residuals is much less serious in Table 10 than in Table 6. The interpolation test resulted in high measures of

TABLE 10 Estimates of the demand parameters $\hat{b}_i$, $\hat{c}_i$, and $\hat{\lambda}$ for the period 1960–80. Taste variable: $s_t = t(-10, \ldots, -1, 0, 1, \ldots, 10)$.

i	Commodity group	Marginal budget share		Coefficient of s_t variable		Multiple correlation coefficient		Serial correlation coefficient
		$\hat{b}_i$	$\lvert t \rvert$ ratio	$\hat{c}_i$	$\lvert t \rvert$ ratio	$R_{y'.us}$	R	
1	Rice	–.0292	2.985	–225.3	2.519	.993	.987	.565
2	Other cereals	–.0030*	.707	53.3*	1.375	.719	.973	.361
3	Fish	.0360	5.351	–180.4	2.930	.967	.993	.296
4+5	Meat, milk, etc.	.1203	5.854	–566.1	3.011	.975	.959	.773**
6	Vegetables	.0288	6.761	–130.9	3.366	.982	.991	.497
7	Processed food	.0161	3.032	17.0*	.350	.981	.987	.038
8	Cakes	.0285	6.868	–135.2	3.559	.982	.974	.311
9	Fruit	.0662	6.624	–448.0	4.898	.946	.923	.620**
10	Beverages	.0677	7.524	–306.0	3.716	.986	.977	.501
11	F.a.f.h.	.0024*	.289	338.8	4.512	.991	.995	.615**
12	Rent	.0277	3.040	86.7*	1.041	.987	.988	.572
13+14	Repairs + water	.0372	6.917	–145.4	2.953	.987	.987	–.084
15	Furniture	.1552	7.844	–1089.6	6.020	.954	.960	.548
16	Fuel + light	.0201	2.958	379.8	6.111	.997	.992	.018
17	Clothes	.1762	16.660	–888.8	9.186	.996	.994	.473
18	Personal effects	.0224	3.169	–76.4*	1.183	.950	.950	.571
19	Medical care	.0427	10.939	–27.8*	.779	.998	.996	–.001
20	Toiletries	.0273	5.297	–71.0*	1.505	.985	.983	.609**
21	Transportation	–.0055*	.295	1233.5	7.303	.996	.995	.390
22	Education	.0114*	.735	–57.2*	.405	.458	.923	.797**
23+24	Tobacco + recreation	.1515	3.920	2239.3	6.335	.998	.998	.679**
$\hat{\lambda}$		99,479	6.846	($\hat{\varphi}$ = –.4095)				

*Insignificant at the 5-percent level ($\hat{b}_i$, $\hat{c}_i$, $R_{y'.us}$).
**Significant at the 5-percent level (serial correlation coefficient).

TABLE 11 Demand elasticities ($\bar{e}_{ij}, \bar{E}_j$) estimated for 21 subgroups[a] at the sample average budget shares ($\bar{w}_j$), for the period 1960–80.[b]

i \ j	1	2	3	4+5	6	7	8	9	10	11
Price elasticities $\bar{e}_{ij}$										
1	.312	.012	.015	.008	.011	.030	.005	−.005	.001	.022
2	.010	.080	.004	.002	.003	.008	.001	−.002	.000	.006
3	−.053	−.016	−.414	−.011	−.016	−.043	−.007	.008	−.002	−.032
4+5	−.110	−.034	−.045	−.834	−.033	−.088	−.015	.016	−.003	−.065
6	−.056	−.017	−.023	−.012	−.432	−.045	−.008	.008	−.002	−.033
7	−.017	−.005	−.007	−.004	−.005	−.143	−.002	.003	−.001	−.010
8	−.082	−.025	−.034	−.017	−.024	−.066	−.615	.012	−.002	−.049
9	−.193	−.060	−.079	−.040	−.058	−.155	−.027	−1.394	−.006	−.115
10	−.128	−.040	−.053	−.026	−.038	−.103	−.018	.019	−.949	−.076
11	−.004	−.001	−.002	−.001	−.001	−.003	−.001	.001	−.000	−.031
12	−.049	−.015	−.020	−.010	−.015	−.039	−.007	.007	−.001	−.029
13+14	−.095	−.029	−.039	−.020	−.028	−.076	−.013	.014	−.003	−.056
15	−.187	−.058	−.077	−.039	−.056	−.150	−.026	.027	−.005	−.111
16	−.027	−.008	−.011	−.006	−.008	−.022	−.004	.004	−.001	−.016
17	−.124	−.038	−.051	−.026	−.037	−.100	−.017	.018	−.004	−.074
18	−.042	−.013	−.017	−.009	−.012	−.034	−.006	.006	−.001	−.025
19	−.093	−.029	−.038	−.019	−.028	−.075	−.013	.013	−.003	−.055
20	−.055	−.017	−.023	−.011	−.017	−.044	−.008	.008	−.002	−.033
21	.006	.002	.002	.001	.002	.005	.001	−.001	.000	.003
22	−.020	−.006	−.008	−.004	−.006	−.016	−.003	.003	−.001	−.012
23+24	−.031	−.009	−.013	−.006	−.009	−.025	−.004	.004	−.001	−.018
Income elasticities $\bar{E}_j$										
	−.670	−.188	.957	1.981	1.013	.314	1.475	3.473	2.310	.070
Annual rates of demand shift $\left[\frac{\partial x_j}{\partial t} / \bar{x}_j\right] \times 100$										
	−2.13	1.38	−1.97	−3.84	−1.90	.14	−2.88	−9.67	−4.30	5.08
Budget shares $\bar{w}_j$										
	.044	.016	.038	.061	.028	.051	.019	.019	.029	.034

[a] For a full list of the commodity groups i, j see Table 1.

[b] $\bar{e}_{ij}$, $\bar{E}_j$, and $\bar{w}_j$ are as defined in Table 3; $\frac{\partial x_j}{\partial t} / \bar{x}_j$ = the annual rate of shift in demand for

means of all the variables, annual rates of demand shift $\left(\frac{\partial x_j}{\partial t} / \bar{x}_j\right)$, and sample mean

12	13+14	15	16	17	18	19	20	21	22	23+24
.013	.004	−.012	.022	.005	.014	.005	.011	.036	.018	.143
.004	.001	−.003	.006	.001	.004	.002	.003	.010	.005	.040
−.019	−.006	.017	−.032	−.007	−.020	−.008	−.016	−.052	−.025	−.204
−.040	−.013	.035	−.066	−.013	−.041	−.016	−.032	−.108	−.052	−.422
−.020	−.007	.018	−.034	−.007	−.021	−.008	−.016	−.055	−.027	−.216
−.006	−.002	.005	−.011	−.002	−.007	−.003	−.005	−.017	−.008	−.067
−.030	−.010	.026	−.049	−.010	−.030	−.012	−.024	−.080	−.039	−.314
−.070	−.023	.061	−.116	−.024	−.072	−.028	−.057	−.189	−.091	−.740
−.046	−.015	.040	−.077	−.016	−.048	−.019	−.038	−.126	−.061	−.492
−.001	−.000	.001	−.002	−.000	−.001	−.001	−.001	−.004	−.002	−.015
−.379	−.006	.015	−.029	−.006	−.018	−.007	−.014	−.048	−.023	−.188
−.034	−.709	.030	−.057	−.012	−.035	−.014	−.028	−.093	−.045	−.363
−.068	−.022	−1.320	−.113	−.023	−.069	−.027	−.055	−.183	−.088	−.717
−.010	−.003	.008	−.214	−.003	−.010	−.004	−.008	−.026	−.013	−.103
−.045	−.015	.039	−.075	−.929	−.046	−.018	−.036	−.121	−.059	−.475
−.015	−.005	.013	−.025	−.005	−.323	−.006	−.012	−.041	−.020	−.160
−.034	−.011	.029	−.056	−.011	−.034	−.698	−.027	−.091	−.044	−.356
−.020	−.007	.017	−.033	−.007	−.021	−.008	−.424	−.054	−.026	−.212
.002	.001	−.002	.003	.001	.002	.001	.002	.049	.003	.022
−.007	−.002	.006	−.012	−.003	−.008	−.003	−.006	−.020	−.160	−.078
−.011	−.004	.010	−.018	−.004	−.011	−.004	−.009	−.030	−.014	−.343
.881	1.704	3.366	.482	2.231	.751	1.671	.995	−.105	.368	.551
1.14	−2.74	−9.73	3.75	−4.63	−1.06	−.45	−1.06	9.74	−.76	3.35
.031	.022	.046	.042	.079	.030	.026	.028	.052	.031	.275

subgroup j calculated at the sample means.

fit. Only two of the 441($N \times T$) measures of fit were less than 80 percent.

Table 11 presents the demand elasticities, annual rates of demand shift, and average budget shares, calculated at sample means. Fruits, beverages, furniture, and clothes have large income elasticities that exceed 2.0. Demand for these subgroups, however, shifts substantially downward year after year, other things being equal. On the other hand, demands for food away from home, fuel and light, transportation, and recreation increase annually, while their income elasticities are quite low.

For the subperiods 1957–80, 1958–80, 1959–80, and 1960–80, estimates of money flexibility at the mid-point were −2.5, −2.7, −2.8, and −2.4, respectively. The corresponding estimates for Leser's elasticity of substitution were 0.89, 0.76, 0.68, and 0.70. The estimated money flexibilities were rather stable.

As some β_{it} estimates have negative values for the period 1960–80 and as there are three subgroups with a negative marginal budget share, we do not propose to discuss here the cost of living index or the subsistence cost for this period.

5 INTERPRETATION OF THE RESULTS

Based on the estimation results for the above four subperiods, demand elasticities and average budget shares can be derived at sample mean levels by subperiod for the two broad categories of food and nonfood. The demand elasticities are obtained from the estimates of income and price elasticities for 21 subgroups of commodities and their sample mean average budget shares, by using Engel aggregation, Cournot aggregation, and the homogeneity condition.[11] Table 12 shows the derived income and price elasticities and average budget shares for food and nonfood in the four sample periods. For the period 1960–80 annual rates of shift in demand at sample means are also presented. The rate of shift for food is −1.9 percent per annum, while both income and price elasticities are appreciably higher than expected.

The derived demand elasticities varied across the sample periods. On examination of the results for the first three periods, it is clear that income and price elasticities for food have been diminishing in absolute terms over time. This is reflected in the fact that the average budget share of food (or Engel coefficient) declines as per capita income grows. The demand for food is more susceptible to income and food price than to nonfood price. Cross price elasticities take negative values, satisfying the theoretical features of the linear expenditure system.[12] This indicates that the income effect of a change in price exceeds the substitution effect, and that the β_i estimates at sample means are positive and can be interpreted as subsistence consumption levels.

According to the analysis of the 21-commodity breakdown, all estimates of β_{it} were positive in the first three subperiods, where own price elasticities were all less than 1.0 in absolute value. Meanwhile, income elasticities were particularly high for such nonfood subgroups as transportation, medical care, furniture, and recreation during the whole period studied. Rent, as well as fuel and light, exhibited an upward tendency in income elasticity. It is

TABLE 12 Demand elasticities and average budget shares for food and nonfood, derived from the results for 21-commodity breakdowns for four different periods.

i	Period												
	1951–61			1960–77			1958–80			1960–80			
	j			j			j			j			$\left(\frac{\partial x_i}{\partial t} / \bar{x}_i\right) \times 100$
	1	2	$\bar{E}_i$	1	2	$\bar{E}_i$	1	2	$\bar{E}_i$	1	2	$\bar{E}_i$	
1 Food	–.36	–.20	.56	–.32	–.15	.47	–.29	–.15	.44	–.60	–.38	.98	–1.92
2 Nonfood	–.53	–.83	1.36	–.36	–.92	1.28	–.37	–.92	1.29	–.20	–.80	1.01	.99
$\bar{w}_j$	.454	.546		.350	.650		.344	.656		.339	.661		

Demand elasticity matrix: $(\bar{e}_{ij}\ \bar{E}_i)$; $(i, j = 1, 2)$.

$\bar{e}_{ij}$ = elasticity of group i with respect to the jth price calculated at the sample means.

$\bar{E}_i$ = income elasticity of group i calculated at the sample means.

$\bar{w}_j$ = budget share of group j calculated at the sample means.

$\frac{\partial x_i}{\partial t} / \bar{x}_i$ = annual rate of shift in demand for group i calculated at the sample means.

beyond question that larger and higher-quality housing continues to be in great demand. At the same time, beverages, food away from home, fruit, and meat all exhibit high income elasticities.

It is clear that these commodity groups with high income elasticity have been rising in their relative position in total expenditure. Rice and other cereals, which have a negative or low income elasticity, have dropped remarkably in their share of the consumer's budget. As a result, income is considered the most important factor in allocating the total budget between different commodities, always assuming that annual increment in income or the annual growth rate thereof is used for the taste variable.

A brief illustration of the changes in prices and their influence on consumption patterns may be useful at this point. Over the period 1958–80, for instance, the current price increased 10 times for fish, 9 times for vegetables, 6 times for other cereals, 5.7 times for food away from home, and 5 times for rice, whereas there was a 4.4-times rise in the CPI. Other subgroups of food commodities advanced relatively slowly in current price. Of the non-food subgroups, education and repairs each went up 8 times, and rent advanced 6 times in price during the period 1958–80. Increases in other prices were relatively small.

No sharp drop was observed in the expenditures in constant prices on fish, vegetables, food away from home, rent, or education, etc., whose prices jumped markedly during the period in question. This suggests that consumption was affected more by income and probably by various dynamic factors than by relative prices. Except for food away from home and rent, the latter subgroups seem to have ceased to grow in terms of per capita consumption.

As is widely recognized, money flexibility estimates are sensitive to differences in the sample period, commodity classification, model specification, whether the model version is static or dynamic, the type of proxy variable used for changing tastes, and so on. On the basis of results for the same commodity classification and model specification, there is some indication that the longer the sample period, the greater the money flexibility in algebraic terms. Since own price elasticities are closely related to the magnitude of money flexibility, they are likely to become larger in absolute value over a longer period of time. Thus, money flexibility is to a large extent associated with substitutability between commodities. For these reasons, we agree with the assertion that too much emphasis should not be placed on the welfare aspect of money flexibility.[13]

Several other notable characteristics of the demand patterns in the 1950s can be singled out. Traditional Japanese dietary habits prevailed, with an increased per capita consumption of rice and fish and less consumption of barley and other miscellaneous grains. Food away from home and animal protein food like milk and eggs exhibited very high income elasticities. In view of the highly income-elastic demand for furniture and repairs (and equipment), it is evident that the Japanese had a growing interest in housing facilities.

In the 1960s and the 1970s, per capita consumption of rice dropped markedly while meat, fruits, beverages, and food away from home remained strongly in demand. Other cereals turned into normal or neutral goods as bread, noodles, etc., became more deeply-rooted in dietary patterns. Milk and egg consumption ceased to grow at a rapid rate. Apart from food consumption, there was great demand for private cars with the advance of motorization into daily life. There was a noticeable rise in the income elasticity for rent, and later also in the demand for fuel and light, indicating a strong demand for more spacious and comfortable housing. Education was essentially inelastic with respect to income and prices.

The introduction of the taste variable into the expenditure functions made it possible to obtain a good fit in the regression of the linear expenditure system to long time series. The lagged increase in deflated income and the lagged rate of increase in deflated income were both found to be fairly effective in structuring a dynamic system of consumer demand, in particular for periods of slow and moderate economic growth when consumers adopt a more prudent attitude toward purchasing. However, time trends seem more suitable for describing changing tastes than the other specifications of the taste variable utilized here.

6 CONCLUDING REMARKS

In this study, changing patterns of Japanese consumer expenditure and demand over the last three decades were analyzed. The analysis was conducted at the subgroup level on the basis of time series of family budget data, using Powell's version of the linear expenditure system. The demand estimation problem was formulated as a complete systems approach within the classical framework of consumer demand theory.

When analyzing the actual situation regarding consumer demand over a long period of time, it is very important to identify the effects of dynamic factors as well as those of income and price changes.[14] For this reason, a proxy for changing tastes was incorporated into the expenditure system. The incorporation of a taste variable led to fairly good regression results and more stable demand and utility parameters were obtained. The taste variable in this study was generally formulated in three ways: as the annual increment in deflated income, as the annual rate of growth of deflated income, or as a time trend. For earlier subperiods the first two specifications were useful.

For later subperiods, a lagged annual increase in deflated income, a lagged annual rate of growth in deflated income, and a time trend were used separately; the time trend proved effective in achieving valid regression results. These approaches give a fairly plausible account of structural change in consumer demand in recent years.

Consumption patterns are considered to have changed substantially toward more "Westernized" living and eating habits since the end of the 1950s and the beginning of the 1960s. With regard to per capita food consumption, rice and fish went down with increases in deflated income, whereas animal protein food, fruit, and beverages increased rapidly. Food away from home increased steadily throughout the period. Turning to nonfood consumption, private transportation practically became a daily necessity. There was a growing demand for more spacious and pleasant accommodation. It is also possible that people's views of education have been changing slightly and that they may be gradually diversifying in various ways.

The dynamic factors affecting tastes could certainly be specified in a more sophisticated and appropriate way, although the estimation problem would then become much more complex. However, it turned out that, in our models, variations in expenditure on each commodity could be explained to a large extent in terms of changes in income and prices. Moreover, it is noteworthy that the taste variables had the effect of stabilizing the demand system as a whole and they considerably reduced the instability of important parameter estimates, such as money flexibility, subsistence consumption levels, etc.

Broadly speaking, estimated average substitution elasticity in Leser's model is inversely proportional to estimated money flexibility, which itself has a close relation to price elasticities. High values of money flexibility were obtained for the lower levels of per capita income in the early years of the period studied. This implies that own price elasticities were small, with rather limited substitutability between different commodities. For periods of more rapid economic growth, money flexibility estimates dropped to some extent, and for recent years they rose appreciably, reflecting the smaller response of consumer demand to price changes.

Since β_{it} estimates were found to be positive in many cases, demand for the respective subgroups tended to be price-inelastic and cross price elasticities between normal goods were negative in sign. The derived price elasticities of food and nonfood were both smaller than one in absolute value.

Marginal and average budget shares of many subgroups changed by varying degrees during the period studied. Owing to income and taste effects, transportation, recreation, and rent showed a notable upward shift in average shares, while on the other hand, rice consumption declined remarkably in terms of its reduced marginal share. There are few subgroups that remained relatively constant in marginal budget share throughout the period.

Results on the cost of living index suggest that it may be desirable to adjust the CPI somewhat downward. The same systems approach can be applied to different levels of commodity breakdown. Furthermore, estimates of demand parameters obtained at a certain level may be consistently aggregated to investigate higher levels of commodity classification. It is likely, however, that a few inferior goods will appear in the demand estimation results or in the linear expenditure system when aggregation takes place; this will cause some difficulties in the commodity aggregation. Accordingly, in this study we applied the dynamic model directly to the expenditure and price data at the subgroup level.

NOTES

1. This is also proved in Sasaki and Saegusa (1972).
2. Leser's dynamic model, which is used to obtain initial values of the marginal budget shares b_i, may be written

$$p_i x_i = p_i \bar{x}_i + \alpha(\bar{w}_i \sum_j p_j \bar{x}_j - p_i \bar{x}_i) + b_i(m - \sum_j p_j \bar{x}_j) + c_i s$$

$$(i, j = 1, 2, \ldots, N)$$

The α is equivalent to the average elasticity of substitution, which is derived by taking all cross elasticities of substitution $\alpha_{ij} (i \neq j)$ as equal at the sample means of all variables.

3. The simple error structure assumed is as follows. All expected values of errors are equal to zero. There are no cross equation correlations and no serial correlations. Errors for each equation are subject to homoscedasticity (see Sasaki 1982).
4. First, if the average cross elasticity of Leser's system takes a negative value, no further computation is conducted. Second, if the estimate of λ is not statistically significant, the result is discarded. On the other hand, unless the parameter $\hat{\lambda}$ is positive, computation is terminated. Third, when the estimate of λ is very small, or in other words, when the estimate of money flexibility $\breve{\omega}$ is extremely high, the result is considered invalid because price effects are liable to fail. Finally, in a few cases, the relative deviation of the parameter λ between two successive rounds did not fall below a certain percentage, but moved cyclically between high values of more than 6 percent. All of these cases are excluded from our discussion.
5. See Powell et al. (1968) and Lluch and Williams (1975). The present study takes a nonlinear approach, by using linear models for many short time series of the whole period under consideration, as suggested by Lluch and Williams (1975).
6. $R_{y'.us}$ indicates the multiple correlation coefficient of the estimating equation, where the dependent variable for the ith subgroup is $y'_i (y'_{it} = p_{it} x_{it} - p_{it} \bar{x}_{it} - \hat{\lambda} z_{it})$ and the independent variables are u and s. R represents the multiple correlation coefficient of the original linear expenditure function, which is measured by the correlation between the actual and estimated expenditures for each subgroup.
7. The following relation exists between own price elasticity $\bar{e}_{ii}$ and income elasticity $\bar{E}_i$ at sample means (see Sasaki 1982):

$$\bar{e}_{ii} = (1 - \bar{w}_i \bar{E}_i) \bar{E}_i / \breve{\omega} - \bar{w}_i \bar{E}_i$$

The first term on the right-hand side usually predominates over the second, especially for precisely defined commodities. Therefore, the own price elasticity is generally proportional to income elasticity and inversely proportional to money flexibility $\breve{\omega}$ in absolute terms, respectively. The own price elasticity is necessarily negative for normal goods, but positive for inferior goods.

8. The own price elasticity evaluated at sample means can also be described as

$$\bar{e}_{ii} = \bar{\beta}_i (1 - b_i) / \bar{x}_i - 1$$

where $\bar{\beta}_i$ denotes the subsistence parameter of the ith commodity, evaluated at sample means. When $\bar{\beta}_i$ is positive in sign, the own price elasticity $\bar{e}_{ii}$ is greater than -1, and if $\bar{\beta}_i$ is negative, $\bar{e}_{ii}$ is less than -1. The marginal budget share b_i is always less than 1.

9. The cross elasticity of substitution α_{ij} in Leser's system (Leser 1960) is defined as

$$\alpha_{ij} = (\partial x_i / \partial p_j)\bar{u} \cdot (p_j / x_j) / w_j$$
$$= (e_{ij} / w_j) + E_i \quad (i \neq j), \quad (i, j = 1, 2, \ldots, N)$$

using our notation. This is the Slutsky elasticity divided by the alien budget share, which is symmetric with respect to i and j. Furthermore, it is also equivalent to the partial elasticity of substitution (see Allen 1966, p. 512):

$$\alpha_{ij} = (\sum_k u_k x_k / x_i x_j) \cdot (\Delta_{ij} / \Delta)$$

where Δ_{ij} is the cofactor of u_{ij} in the bordered Hessian determinant

$$\Delta = \begin{vmatrix} u_{11} & u_{12} & \cdots & u_{1N} & u_1 \\ u_{21} & u_{22} & \cdots & u_{2N} & u_2 \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ u_{N1} & u_{N2} & \cdots & u_{NN} & u_N \\ u_1 & u_2 & \cdots & u_N & 0 \end{vmatrix},$$

u_i is the first derivative with respect to x_i, and u_{ij} is the second derivative with respect to x_i and x_j of utility function u. All the α_{ij} values are set equal to a constant α in Leser's system.

10. The cost of living index is calculated using the following formula:

$$C_{0t} = (1 + \varphi)(\sum_i p_{it}\beta_{it} / \sum_i p_{i0}\beta_{it}) - \varphi\Pi_i(p_{it}/p_{i0})^{b_i}$$

$$(t = 0, 1, 2, \ldots, T-1)$$

p_{it} and p_{i0} indicate the ith price in year t and in the base year, respectively. The β_{it} value is calculated from the following equation, using the estimates of b_i, c_i, and λ, and observed data:

$$\beta_{it} = \bar{x}_i - (b_i\lambda/\bar{p}_i) + (c_i s_t / p_{it})$$

11. The following relationships are used to derive the income and price elasticities for broader groups of commodities, evaluated at sample means:

$$\sum_i \bar{w}_i \bar{E}_i = 1 \quad \text{(Engel aggregation)}$$

$$\sum_i \bar{w}_i \bar{e}_{ij} = -\bar{w}_j \quad \text{(Cournot aggregation)}$$

and

$$\sum_j \bar{e}_{ij} = -\bar{E}_i \quad \text{(homogeneity condition)}$$

The first two relationships originate from the budget equation or adding-up criterion.

12. Cross price elasticities are confined to negative values for all pairs of commodities provided that both marginal budget shares and subsistence parameters are positive for all commodities. They can also be described in the form of expressions:

$$\bar{e}_{ij} = -b_i\bar{p}_j\beta_j/(\bar{p}_i\bar{x}_i) \qquad (i,j = 1,2,\ldots,N;\, i \neq j)$$

which are evaluated at sample means.
13. For a detailed discussion see Lluch and Powell (1975).
14. In an excellent empirical study, Yoshihara (1969) fitted Stone's linear expenditure system to Japanese expenditure data over a long period using a static model.

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