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Further Results of the Dynamic Demand Estimation for Japan

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FURTHER RESULTS OF THE DYNAMIC DEMAND ESIMATION FOR JAPAN

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PREFACE

The authors have been working on the demand module of the Japanese Agricultural Model which is associated with the IIASA Basic Linked System. This paper is part of the results of our work with the Food and Agriculture Program.

Consumer demand estimation for Japan in the postwar period is a subject of great interest to us. The collaborative paper by K. Sasaki, "Estimation of the Consumer Demand System in Postwar Japan" forms Part I of this study. The present paper, "Further Results of the Dynamic Demand Estimation for Japan", is an extension of the former paper and contributes Part II of our study.

These two papers should be put together in understanding the varied structures of consumer demand at the subgroup level in Japan for the last three decades.

ACKNOWLEDGEMENTS

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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. In the end it is proposed to link models to twenty countries, which together account for nearly 80 per cent 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 second paper on consumer demand estimation for Japan in the postwar period discusses the dynamic aspects of the demand structure in the 1951–80 period. It focuses on the specification of a proxy variable for changing tastes. Dr. Sasaki and Dr. Fukagawa show important findings with regard to the empirical implementation of their dynamic version of the liner expenditure system and on the varied structures of Japanese consumer demand. This is a further step towards completion of a detailed agricultural policy model for Japan.

Kirit Parikh
Program Leader

CONTENTS

FURTHER RESULTS OF THE DYNAMIC DEMAND ESTIMATION FOR JAPAN

Kozo Sasaki
Yoshihiro Fukagawa

1. INTRODUCTION

This paper is an attempt to explore the dynamic demand relations that were effective in Japan in the 1951–80 period. 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 confirming the 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 the time series of family budget data in the 1951–77 period.

The same method is adopted here: a simplified version of the linear expenditure system developed by A. A. Powell for the sake of computational convenience. Expenditure and price data were updated, adding three more years to the time series. Four alternative specifications of the taste variable were undertaken here in order to take due account of the recent structural change in consumer demand. The first two factors are current annual increase in income and current annual rate of increase in income, which can be seen in some of the conventional demand analyses in econometric models. The remaining factors are lagged annual increase in income and lagged annual rate of increase in income.

The commodity definition remains unchanged; however, the original 24 subgroups have been adjusted somewhat, yielding a 21–commodity breakdown for all cases under consideration. Moreover, many segments of the whole observation period have been chosen for estimating the dynamic model. All these endeavors were made with the intention of satisfying the theoretical restraints imposed on the model and of obtaining as far as possible a good fit of the model to empirical data.

It is also 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 different cases could be compared in various respects. However, this study picks up only three subperiods with fairly good results for detailed discussion. It is noteworthy that most statistical tests are implemented under classical 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 expression:

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

where

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

and

$$u_t = m_t - \Sigma_j p_{jt}\overline{x}_j \qquad \begin{matrix}(i,j = 1,2,\ldots,N)\\(t = 1,2,\ldots,T)\end{matrix}$$

The same notation is used here, p_i and x_i being the price and quantity consumed per capita, m per capita income, s taste variable and ε_i the error term. $\overline{p}_i$ is the sample mean of p_i and $\overline{x}_i$ is the ratio of the sample mean expenditure to the mean price $\overline{p}_i$. 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 relationships:

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

and

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

$\check{\omega}$ 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 $\check{\omega}$ Then λ is interpreted as the supernumerary income. b_i represents the marginal budget share and c_i denotes the coefficient of taste variable s_t.

The taste variable s_t could be specified in a proper way as the occasion requires. C.E.V. Leser (1960) mentioned that it is easy to estimate a set of regression equations with the same independent variables under the least squares assumptions.[1] In compliance with Leser's argument, Powell's linear expenditure system (Powell, 1966) also contains a dynamic factor common to all equations, which allows for shifts of expenditure and demand functions.

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

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

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

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

Equation (5) is the same as equation (4), except that the former has a one-year lag. It simply suggests that, more recently, the consumer responds slowly to an annual increment or an annual growth rate in real income.

The dynamic model is considered to satisfy the homogeneity condition only at the mid-point of the sample period. If 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 (or 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 identical with the previous ones: the Annual Reports published by the Office of the Prime Minister, Japan (1950–1980). *All Households in Cities with Population of 50,000 or More* are taken up in this study, since they have long time series on expenditures and prices in the postwar period. Price indices in the Laspeyres form are available for all subgroups and they are taken as individual prices for them, with all of the 1970 indices being unity. Hence, the associated quantities represent expenditures in 1970 constant prices.

The commodity grouping remains the same as before. A 21–commodity breakdown is employed here by combining several original subgroups into broader groups. The present data sets include additional data on the most recent three years as well as the time series used previously. There are two commodity lists which differ slightly from each other. They can be seen in some of the following tables.

It should be noted that both expenditure and price data are deflated by the General Consumer Price Index so as to ensure that consumer demand does not respond to changes in nominal prices, but to changes in relative prices. This analysis takes into account the changes in prices and income relative to the General Consumer Price Index. Given the values of the taste variable, current (or nominal) expenditure functions are homogeneous of degree one in current prices. It follows immediately that demand functions are homogeneous of degree zero in all current prices.

Starting with the estimation of Leser's dynamic model[2], nonlinear estimation of Powell's dynamic model is undertaken by an iterative procedure. The estimation criterion is again to minimize the sum of squared residuals over all commodities and all observation 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 is set to terminate when the relative deviation of the parameter $\hat{\lambda}$ between two successive rounds is reduced below 0.01 percent. The convergence of estimates in this context is generally fast. It is usually reached within 20 rounds. However, convergence is not always achieved[4].

As the sample period extends over a longer period, the linearity assumption of expenditure functions tends to be more rigid. In particular, Engel curves would not remain linear for some commodities, as frequently referred to[5]. As a matter of fact, a few commodities change from normal goods to inferior goods or *vice versa*. A few others actually remain rather irresponsive to income changes. Therefore, sample periods should be chosen properly in accordance with particular phases of demand structure.

4. ESTIMATION RESULTS

First of all, the dynamic models were applied to many sample periods with a couple of related descriptions for the proxy of the taste variable: namely, current annual increase in deflated income and its current annual rate of increase. The whole period could be roughly divided into two parts in estimating dynamic demand models. The first one refers to the 1950's, the early stage of the postwar period. The second part consists of the 1960's and 1970's which would be designated as a more advanced stage from the viewpoint of economic development or in terms of consumption levels and patterns.

Estimation results for the three subperiods, 1951–61, 1960–77 and 1958–80, are selected here for detailed discussion. For more recent years, the specification of the taste variable was modified. The commodity grouping for early subperiods is different from that of recent subperiods. At any rate, an effort was made to enhance the goodness of fit of the models and to handle as many normal goods as possible.

4.1. The 1951–61 Period

For the early postwar years, five subperiods between 1951 and 1965 were analyzed, with all subperiods starting in 1951. One of the good results is presented in Table 1, which reports the estimates of demand parameters and relevant coefficients. All commodities except other cereals and vegetables were found to be normal goods (F.a.f.h. is the abbreviation for food away from home). Other cereals are identified as an inferior good, while vegetables hardly respond 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 depicted in terms of 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 total test within the sample period. Only two of them took values of less than 80 percent. These measures indicate the ratios of estimated to actual expenditures, which are no more than the ratios of estimated to actual quantities purchased. Therefore, the fitted system has a high predictive power in the early subperiod.

The income flexibility estimate at sample mean $\hat{\phi}$ is derived from the parameter $\hat{\lambda}$ and sample mean income $\overline{m}$. It yields the money flexibility $\check{\omega}^e$ of −3.9. 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 the elasticity form. The estimates of behavioral parameters in Table 1, together with observed data, provide a complete set of income and price elasticities, evaluated at sample means of all variables. Table 2 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]. A striking feature is that rice proved to be a normal good, with an income elasticity of 0.23 and 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 amount to 44 percent of the total budget. The Engel coefficient was still as high as 45 percent on the average, as will be illustrated later. It would seem to be a sort of transitional period from a low standard of living to comfortable living conditions.

Own price elasticities were all less than 1 in absolute value for normal goods. It follows from the outcome that all estimates of β_{it} were positive in sign[8]. β_{it} represents the subsistence consumption level, although this interpretation is not allowed for inferior goods. The β_{it} estimates for most subgroups do not vary significantly within the sample period; nor does the subsistence cost.

Table 3 presents the money flexibility estimates $\check{\omega}^e$ at sample means, which have been calculated by the sample period and by the alternative specification

Table 1. Estimates of Demand Parameters $\hat{b}_i$, $\hat{c}_i$, $\hat{\lambda}$ in 1951-1961

Coefficient i	Marginal budget share $\hat{b}_i$	 $\|t\|$ ratio	Coefficient of s_t variable $\hat{c}_i$	 $\|t\|$ ratio	Multiple correlation coefficient $R_{y'.us}$	 R	Serial correlation coefficient
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 + fruits	.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 Tolilet care	.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	($\hat{\phi}$ = -.2580)				

Taste variable $s_t = m_t - m_{t-1}$

*insignificant at 5 percent ($\hat{b}_i$, $\hat{c}_i$, $R_{y'.us}$)

All serial correlation coefficients are insignificant at 5 percent.

Table 2. Demand Elasticities Estimated for Twenty-one Subgroups at the Sample Means of All Variables in 1951-1961 [$\bar{e}_{ij}$, $\bar{E}_i$] and Sample Mean Average Budget Shares [$\bar{w}_j$]

i \ j	1	2	3	4	5	6	7	8-9	10	11	12	13	14	15	16	17-18	19	20	21	22	23-24	$\bar{E}_i$
1 Rice	-.087	-.010	-.010	-.004	-.003	-.009	-.015	-.008	-.004	-.002	-.004	-.002	-.001	-.002	-.010	-.020	-.003	-.006	-.003	-.005	-.027	.234
2 Other cereals	.124	.326	.047	.018	.014	.040	.068	.037	.018	.009	.019	.009	.004	.008	.046	.093	.013	.029	.014	.025	.126	-1.088
3 Fish	-.021	-.008	-.055	-.003	-.002	-.007	-.011	-.006	-.003	-.002	-.003	-.001	-.001	-.001	-.008	-.016	-.002	-.005	-.002	-.004	-.021	.183
4 Meat	-.161	-.058	-.061	-.386	-.018	-.052	-.088	-.048	-.023	-.012	-.025	-.011	-.005	-.011	-.059	-.120	-.017	-.037	-.018	-.033	-.163	1.406
5 Milk + eggs	-.219	-.079	-.083	-.032	-.578	-.071	-.120	-.065	-.031	-.016	-.034	-.015	-.006	-.015	-.081	-.163	-.024	-.050	-.025	-.044	-.222	1.913
6 Vegetables	.018	.007	.007	.003	.002	.047	.010	.005	.003	.001	.003	.001	.001	.001	.007	.014	.002	.004	.002	.004	.018	-.159
7 Processed food	-.079	-.028	-.030	-.011	-.009	-.026	-.221	-.023	-.011	-.006	-.012	-.006	-.002	-.005	-.029	-.059	-.009	-.018	-.009	-.016	-.080	.690
8-9 Cakes + fruits	-.094	-.034	-.036	-.014	-.011	-.030	-.051	-.239	-.013	-.007	-.014	-.007	-.003	-.006	-.035	-.070	-.010	-.022	-.011	-.019	-.095	.819
10 Beverages	-.162	-.058	-.062	-.023	-.019	-.052	-.089	-.048	-.388	-.012	-.025	-.011	-.005	-.011	-.060	-.120	-.017	-.037	-.018	-.033	-.164	1.414
11 F.a.f.h.	-.264	-.096	-.101	-.038	-.030	-.086	-.145	-.079	-.038	-.616	-.040	-.019	-.008	-.017	-.098	-.197	-.029	-.061	-.030	-.054	-.268	2.312
12 Rent	-.091	-.033	-.035	-.013	-.010	-.029	-.050	-.027	-.013	-.007	-.219	-.006	-.003	-.006	-.034	-.068	-.010	-.021	-.010	-.018	-.092	.795
13 Repairs	-.192	-.069	-.073	-.028	-.022	-.062	-.105	-.057	-.028	-.014	-.029	-.445	-.006	-.013	-.071	-.142	-.021	-.044	-.022	-.039	-.194	1.675
14 Water charges	-.114	-.041	-.043	-.017	-.013	-.037	-.062	-.034	-.016	-.009	-.017	-.008	-.260	-.008	-.042	-.085	-.012	-.026	-.013	-.023	-.115	.995
15 Furniture	-.337	-.122	-.128	-.049	-.039	-.109	-.185	-.100	-.048	-.025	-.052	-.024	-.010	-.782	-.124	-.250	-.036	-.078	-.038	-.068	-.341	2.945
16 Fuel + light	-.081	-.029	-.031	-.012	-.009	-.026	-.044	-.024	-.012	-.006	-.012	-.006	-.002	-.005	-.211	-.060	-.009	-.019	-.009	-.016	-.082	.704
17-18 Clothes + personal effects	-.138	-.050	-.053	-.020	-.016	-.045	-.076	-.041	-.020	-.010	-.021	-.010	-.004	-.009	-.051	-.415	-.015	-.032	-.016	-.028	-.140	1.210
19 Medical care	-.194	-.070	-.074	-.028	-.022	-.063	-.106	-.058	-.028	-.015	-.030	-.014	-.006	-.013	-.072	-.144	-.458	-.045	-.022	-.039	-.196	1.695
20 Toilet care	-.091	-.033	-.035	-.013	-.010	-.029	-.050	-.027	-.013	-.007	-.014	-.006	-.003	-.006	-.034	-.068	-.010	-.226	-.010	-.018	-.092	.795
21 Transportation	-.141	-.051	-.054	-.020	-.016	-.046	-.077	-.042	-.020	-.011	-.022	-.010	-.004	-.009	-.052	-.105	-.015	-.032	-.333	-.029	-.143	1.230
22 Education	-.115	-.041	-.044	-.017	-.013	-.037	-.063	-.034	-.017	-.009	-.018	-.008	-.003	-.008	-.042	-.085	-.012	-.026	-.013	-.282	-.116	1.004
23-24 Tobacco + recreation	-.178	-.064	-.068	-.026	-.020	-.058	-.098	-.053	-.026	-.013	-.027	-.013	-.005	-.012	-.066	-.132	-.019	-.041	-.020	-.036	-.582	1.557
$\bar{w}_j$	.122	.032	.046	.026	.026	.036	.076	.043	.026	.021	.022	.014	.004	.032	.052	.124	.022	.033	.019	.031	.194	

$\bar{e}_{ij}$ = elasticity of subgroup i with respect to the j^{th} price calculated at sample means

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

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

of the taste variable. Most of the estimated money flexibilities lie within the range of −2.1 to −4.0. As the sample period is protracted, the absolute value of money flexibility goes down substantially. Obviously, it declines with a rise in deflated income in those early years. An annual increase in income for the taste variable brings about the more stable results associated with the value of money flexibility than an annual rate of increase in income.

As regards the estimates of the average substitution elasticity in Leser's model[9], many of them centered between 0.3 and 0.4. This reveals that, on the whole, the substitutability between different subgroups of commodities is limited to a considerable extent. An extreme limitation of the substitutability emerged particularly in the subperiods 1951−61 and 1951−62.

After all of the β_{it}'s were calculated, the cost of living index[10] and subsistence cost were estimated for every year in this subperiod, despite the negative marginal budget shares for both other grains and vegetables. These two subgroups comprise only a small portion of the budget. The results are summarized in Table 4. The cost of living index 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 surpasses 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 4.

4.2. The 1960−77 Period

This subperiod includes the 1960's with the rapid growth of Japanese economy, during which consumer demand expanded greatly as a whole and became diversified. It is noticeable that some static and dynamic versions of the present expenditure system were fairly well suited for periods of about twenty years until 1977. One of the good dynamic results chosen is presented in Table 5 and shows estimated demand parameters and related results of a subperiod in relatively recent years.

Rice changed its sign of marginal budget share and is now the only inferior good. Both other cereals and vegetables are ascertained to be normal goods. It is noted that there is little difference in the commodity classification between Tables 1 and 5. Estimates of marginal budget shares for fish and education are not significant. In other words, per capita expenditures in constant prices on both fish and education did not vary significantly with income. The coefficient of the taste variable is significant for toilet care 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 of the 1951−61 period, namely 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 total test were very high. Only one of the 378 (N × T) point estimates did not touch the level of 80 percent. The estimated income flexibility $\hat{\phi}$ moved up, compared with the result in Table 1, and the corresponding money flexibility $\check{\omega}^e$ was −2.5.

Estimated demand elasticities and sample mean average budget shares are given in Table 6. In the food category, the income elasticities for food away from home, beverages, fruits and meat, etc., are greater than 1. Aside from other cereals and vegetables, however, most of the income elasticities went down. On the other hand, own price elasticity rose for beverages, cakes and fruits. As for the nonfood category, there are quite a few subgroups whose income elasticities exceed 1. Demand for transportation, medical care, furniture and recreation

Table 3. Estimated Money Flexibility $\check{\omega}^e$ by the Sample Period in Early Years

s_t variable / Period	$s_t = m_t - m_{t-1}$	$s_t = (m_t - m_{t-1})/m_{t-1}$
1951 - 1961	-3.877	-4.623
1951 - 1962	-3.571	-4.012
1951 - 1963	-2.915	-3.075
1951 - 1964	-2.216	-2.303
1951 - 1965	-2.065	-2.068

$\check{\omega}^e = 1/\hat{\phi} = -\bar{m}/\hat{\lambda}$, $-\varphi = (m - \Sigma_i p_i \beta_i)/m$

Subgroups of cakes and fruits; clothes and personal effects; and of tobacco and recreation are further aggregated into a single group, respectively.

Table 4. Estimates of Cost of Living Index and Subsistence Cost by Year in 1951 - 1961

Year	Cost of living index	Subsistence cost
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

Cost of living index in 1951 = 100.0

Subsistence cost = $\Sigma_i \, p_{it} \, \hat{\beta}_{it}$

Table 5. Estimates of Demand Parameters $\hat{b}_i$, $\hat{c}_i$, $\hat{\lambda}$ in 1960 - 1977

Coefficient i	Marginal Budget share $\hat{b}_i$	 $\lvert t \rvert$ ratio	Coefficient of s_t variable $\hat{c}_i$	 $\lvert t \rvert$ ratio	Multiple correlation coefficient $R_{y'.us}$	 R	Serial correlation coefficient
1 Rice	-.0556	20.637	-.0249*	.962	.983	.971	.624
2 Other cereals	.0044	5.579	-.0036*	.478	.829	.967	.229
3 Fish	.0010*	.684	.0175*	1.197	.318*	.989	-.025
4-5 Meat, Milk, etc.	.0632	17.969	.0160*	.475	.978	.969	.742**
6 Vegetables	.0108	9.348	.0123*	1.110	.924	.983	.221
7 Processed food	.0181	21.731	.0090*	1.120	.985	.991	.159
8 Cakes	.0136	18.003	.0073*	1.010	.978	.978	.351
9 Fruits	.0233	12.714	.0204*	1.159	.957	.935	.555
10 Beverages	.0409	25.353	.0195*	1.257	.989	.980	.467
11 F.a.f.h.	.0448	37.786	-.0034*	.295	.995	.996	.536
12 Rent	.0379	23.306	-.0031*	.198	.987	.988	.479
13-14 Repaires + water	.0162	10.116	.0070*	.458	.935	.965	.446
15 Furniture	.0705	13.931	.0733*	1.509	.964	.932	.582
16 Fuel + light	.0476	28.031	-.0157*	.960	.991	.970	.337
17 Clothes	.0817	30.881	.0529*	2.082	.992	.991	.228
18 Personal effects	.0135	10.535	.0167*	1.360	.939	.950	.571
19 Medical care	.0391	63.131	.0089*	1.498	.998	.997	-.029
20 Toilet care	.0190	22.937	.0235	2.964	.986	.986	.564
21 Transportation	.1129	25.142	-.0303*	.703	.989	.982	.171
22 Education	.0041*	1.389	-.0201*	.717	.398*	.866	.799**
23-24 Tobacco + recreation	.3930	45.030	-.1834	2.188	.996	.996	.569
$\hat{\lambda}$	93,107	3.143	($\hat{\phi}$ = -.4028)				

Taste variable $s_t = m_t - m_{t-1}$

*insignificant at 5 percent ($\hat{b}_i$, $\hat{c}_i$, $R_{y'.us}$)

**significant at 5 percent (serial correlation coefficient) are highly responsive to income changes. The absolute values of own price elasticity went up conspicuously for transportation, medical care, recreation, rent, and for fuel and light. Own price elasticities were all less than 1 in absolute value, which stems from the fact that all of the β_{it} estimates were positive values.

The average budget shares for rice and other cereals are much smaller than before. Those for food away from home, meat, milk, etc., and beverages apparently went up. Of the nonfood subgroups, recreation and transportation sharply expanded their shares of the total budget.

Table 7 reports the estimates of money flexibility for relatively recent subperiods. The estimates for the 1951–77 period are mentioned for reference, to provide information about the behavior of money flexibility over a longer period. Money flexibilities are rather stable in the recent three subperiods: 1958–77, 1959–77 and 1960–77. They fall in the range from −2.1 to −2.7. Those estimates for the 1958–79 are more or less far from the above range. Moreover, the present specification of the taste variable does not seem to be suitable for more recent years. This issue will be discussed later. Leser's elasticities of substitution were estimated at 0.6 to 0.7 except for the 1951–77 period, whose values were slightly more than 1.

Although the estimates of β_{it} are all positive, some of them cannot be taken as subsistence parameters for an inferior good, rice. Nevertheless, approximate estimates of subsistence cost by year have been obtained using all the estimated demand parameters. They are shown in Table 8. The estimate of subsistence cost goes up over time. The level of estimated subsistence cost differs considerably between the two subperiods, 1951–61 and 1960–77. This shows that a substantial structural change in consumer demand took place around 1960.

The cost of living indices computed for comparison years are all less than 100. It is obvious that this result also has theoretical support.

4.3. The 1958–80 Period

The preceding specifications of the taste variable did not prove suitable for estimating the dynamic model in more recent years. The static model did not fit the latest data sets, either. Accordingly, another pair of taste variables was implemented separately for the estimation of dynamic expenditure systems: that is, a lagged annual change in deflated income and a lagged annual rate of change in deflated income. A one-year lag was put into the previous taste variables to make a simple modification of them. The new taste variables are predetermined variables in the expenditure system. They brought forth good results for some cases covering more recent years.

An example of the results is shown in Table 9 in terms of estimated demand parameters and related coefficients. The marginal budget share takes a negative value for fish as well as rice. The growth of expenditure in constant prices on fish has been so little in the past that income responsiveness of fish consumption turned out to be insignificant in the 1960–77 period. Over a longer period of time, as is the case in the present subperiod, the income elasticity of fish declines to a negative value. Aside from rice, it is frequently said that reduction in fish consumption as a whole is due to its sharp increase in price associated with the 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: namely, repairs and water,

Table 6. Demand Elasticities Estimated for Twenty-one Subgroups at the Sample Means of all Variables in 1960-1977 [$\bar{e}_{ij}, \bar{E}_i$] and Sample Mean Average Budget Shares [$\bar{w}_j$]

i \ j	1	2	3	4-5	6	7	8	9	10	11	12	13-14	15	16	17	18	19	20	21	22	23-24	$\bar{E}_i$
1 Rice	.553	.017	.044	.044	.029	.054	.017	.012	.016	.017	.019	.018	.022	.026	.056	.030	.011	.024	.002	.034	.127	-1.170
2 Other cereals	-.019	-.112	-.010	-.010	-.007	-.012	-.004	-.003	-.004	-.004	-.004	-.004	-.005	-.006	-.013	-.007	-.003	-.005	-.000	-.008	-.029	.269
3 Fish	-.002	-.000	-.012	-.001	-.001	-.001	-.000	-.000	-.000	-.000	-.000	-.000	-.001	-.001	-.001	-.001	-.000	-.001	-.000	-.001	-.003	.027
4-5 Meat, milk etc.	-.070	-.014	-.038	-.444	-.025	-.046	-.015	-.011	-.013	-.015	-.016	-.016	-.019	-.022	-.049	-.025	-.010	-.020	-.001	-.029	-.109	1.008
6 Vegetables	-.026	-.005	-.014	-.014	-.158	-.017	-.005	-.004	-.005	-.005	-.006	-.006	-.007	-.008	-.018	-.009	-.004	-.007	-.001	-.011	-.040	.369
7 Processed food	-.024	-.005	-.013	-.013	-.008	-.153	-.005	-.004	-.005	-.005	-.005	-.005	-.007	-.008	-.016	-.009	-.003	-.007	-.000	-.010	-.037	.341
8 Cakes	-.048	-.010	-.025	-.025	-.017	-.031	-.284	-.007	-.009	-.010	-.011	-.011	-.013	-.015	-.033	-.017	-.007	-.014	-.001	-.020	-.074	.680
9 Fruits	-.082	-.017	-.044	-.044	-.029	-.054	-.017	-.485	-.016	-.017	-.019	-.018	-.022	-.026	-.057	-.030	-.011	-.024	-.002	-.034	-.127	1.174
10 Beverages	-.096	-.020	-.051	-.051	-.034	-.063	-.020	-.014	-.571	-.020	-.022	-.021	-.026	-.030	-.066	-.035	-.013	-.028	-.002	-.040	-.149	1.373
11 F.a.f.h.	-.096	-.020	-.051	-.051	-.034	-.063	-.020	-.014	-.018	-.574	-.022	-.021	-.026	-.030	-.066	-.035	-.013	-.028	-.002	-.040	-.149	1.375
12 Rent	-.085	-.018	-.046	-.045	-.030	-.056	-.018	-.013	-.016	-.018	-.510	-.019	-.023	-.027	-.059	-.031	-.012	-.025	-.002	-.035	-.132	1.217
13-14 Repairs + water	-.051	-.011	-.028	-.027	-.018	-.034	-.011	-.008	-.010	-.011	-.012	-.308	-.014	-.016	-.035	-.019	-.007	-.015	-.001	-.021	-.080	.736
15 Furniture	-.104	-.021	-.056	-.055	-.037	-.068	-.022	-.016	-.020	-.022	-.024	-.023	-.627	-.033	-.072	-.037	-.014	-.030	-.002	-.043	-.161	1.486
16 Fuel + light	-.081	-.017	-.043	-.043	-.029	-.053	-.017	-.012	-.015	-.017	-.018	-.018	-.022	-.491	-.056	-.029	-.011	-.023	-.002	-.033	-.125	1.155
17 Clothes	-.070	-.015	-.038	-.038	-.025	-.046	-.015	-.011	-.013	-.015	-.016	-.016	-.019	-.022	-.455	-.025	-.010	-.020	-.001	-.029	-.109	1.008
18 Personal effect	-.031	-.006	-.016	-.016	-.011	-.020	-.006	-.005	-.006	-.006	-.007	-.007	-.008	-.010	-.021	-.188	-.004	-.009	-.001	-.013	-.048	.440
19 Medical care	-.108	-.022	-.058	-.057	-.038	-.070	-.022	-.016	-.021	-.022	-.024	-.024	-.029	-.034	-.074	-.039	-.635	-.031	-.002	-.045	-.167	1.540
20 Toilet care	-.047	-.010	-.025	-.025	-.017	-.031	-.010	-.007	-.009	-.010	-.011	-.010	-.013	-.015	-.033	-.017	-.007	-.287	-.001	-.020	-.074	.678
21 Transportation	-.168	-.035	-.090	-.090	-.060	-.110	-.035	-.025	-.032	-.035	-.038	-.037	-.046	-.053	-.116	-.061	-.023	-.049	-.973	-.070	-.261	2.408
22 Education	-.009	-.002	-.005	-.005	-.003	-.006	-.002	-.001	-.002	-.002	-.002	-.002	-.003	-.003	-.006	-.003	-.001	-.003	-.000	-.057	-.014	.132
23-24 Tobacco + recreation	-.103	-.021	-.055	-.055	-.037	-.067	-.021	-.015	-.020	-.021	-.023	-.023	-.028	-.033	-.071	-.037	-.014	-.030	-.002	-.043	-.753	1.473
$\bar{w}_j$	.048	.016	.038	063	.029	.053	.020	.020	.030	.033	.031	.022	.047	.041	.081	.031	.025	.028	.047	.031	.267	

$\bar{e}_{ij}$ = elasticity of subgroup i with respect to the j^{th} price calculated at sample means

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

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

Table 7. Estimated Money Flexibility $\check{\omega}^e$ by the Sample Period in Relatively Recent Years

s_t variable / Period	$s_t = m_t - m_{t-1}$	$s_t = (m_t - m_{t-1})/m_{t-1}$
1951 - 1977	-1.186	-1.149
1958 - 1977	-2.296	-2.078
1959 - 1977	-2.702	-2.419
1960 - 1977	-2.482	-2.261
1958 - 1979	-3.720*	-3.058

$\check{\omega}^e = 1/\hat{\phi} = -\bar{m}/\hat{\lambda}$, $-\varphi = (m - \Sigma_i p_i \beta_i)/m$

Subgroups of meat, milk and eggs; repairs and water charges; and of tobacco and recreation are further aggregated into a single group, respectively.

*The corresponding $\hat{\lambda}$ and $\hat{\phi}$ are significant at 10 percent, but not significant at 5 percent

Table 8. Estimates of Cost of Living Index and Subsistence Cost by Year in 1960-1977

Year	Cost of living index	Subsistence cost	Year	Cost of living index	Subsistence cost
1960	100.0	135,629	1969	98.7	137,775
1961	99.8	135,543	1970	98.6	138,099
1962	99.2	135,363	1971	99.0	138,616
1963	98.7	135,464	1972	99.0	139,000
1964	98.8	135,798	1973	98.8	140,380
1965	97.7	135,584	1974	98.5	140,224
1966	98.1	135,376	1975	98.8	141,907
1967	98.2	136,004	1976	99.3	143,526
1968	98.3	136,673	1977	99.4	143,451

Cost of living index in 1960 = 100.0

Subsistence cost = $\Sigma_i p_{it} \hat{\beta}_{it}$

Table 9. Estimates of Demand Parameters $\hat{b}_i$, $\hat{c}_i$, $\hat{\lambda}$ in 1958-1980

Coefficient	Marginal budget share		Coefficient of S_t variable		Multiple correlation coefficient		Serial correlation coefficient
i	$\hat{b}_i$	|t| ratio	$\hat{c}_i$	|t| 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 Fruits	.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 Personnal effect	.0152	11.911	.0223*	1.369	.936	.944	.580**
19 Medical care	.0397	88.200	-.0008*	.140	.999	.998	-.062
20 Toilet care	.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	($\hat{\phi}$ = -.3733)				

Taste variable $s_t = m_{t-1} - m_{t-2}$

*insignificant at 5 percent ($\hat{b}_i$, $\hat{c}_i$, $R_{y'.us}$)

**significant at 5 percent (serial correlation coefficient) furniture, and tobacco and recreation. At the 10-percent level, for instance, it is significant for five more subgroups as far as the t-ratio test is concerned. They are rice, cakes, fuel and light, clothes and toilet care.

Multiple correlation coefficients are all significant, but nearly half of all subgroups have positive serial correlation in the residuals. Measures of fit in the total test were mostly 80 percent or more. Of the 483 ($N \times T$) point estimates for measures of fit, only 5 estimates were at the level of 70 percent and only three fell below 70 percent. The value of income flexibility ϕ moved down, and the money flexibility $\check{\omega}^e$ of −2.7 was obtained.

Income and price elasticities were estimated and are shown in Table 10. They are similar to those elasticities for the 1960−77 period in Table 6. Food away from home, beverages, fruits, and meat, etc. are elastic with respect to income within food subgroups. In the non-food category, transportation, medical care, furniture, and tobacco and recreation are very high in income elasticity. Own price elasticities are mostly lower than the 1960−77 results in Table 6.

Table 11 reports the estimates of money flexibilities for more recent subperiods. The estimated money flexibility ranges from − 2.5 to −3.2 except 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. Besides, the addition of the latest three years to the time series has an appreciable effect on the value of money flexibility. Leser's elasticities of substitution centered about 0.6 in the four subperiods and those for the 1952−80 period were close to 1.0.

All β_{it} estimates were found to be positive values. They change more or less 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 12. These results obtained for the interval between 1960 and 1977 in Table 12 are comparable to the results reported in Table 8. However, there are small differences in the subsistence cost in that the present results in the subsistence cost by year are higher than the previous ones by 5 to 6 percent.

Finally, let us briefly touch upon the results for the 1960−80 period. Again, the lagged annual change in deflated income plays an important role in depicting the changes in tastes. Rice and fish have negative marginal budget shares while all other subgroups have positive ones. Repairs and water, and furniture exhibit positive coefficients of taste variables 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.

Income elasticities evaluated at sample means do not vary so much from the 1958−80 estimates, but own price elasticities decline significantly owing to the higher value of money flexibility, − 3.1. Multiple correlation coefficients and measures of fit in the total test are very high.

Estimates of the cost of living index are slightly different from those of Table 12 for the interval between 1975 and 1980, but they do not rise to 100 except for the base year, 1960. The subsistence cost by year was computed somewhat higher than that of the 1958−80 period.

5. INTERPRETATION OF THE RESULTS

From the estimation results for the above three subperiods with a 21-commodity breakdown, demand elasticities and average budget shares can be derived at sample mean levels for the two broad categories of food and nonfood by subperiod. Those demand elasticities are obtained on the basis of the

Table 10. Demand Elasticities Estimated for Twenty-one Subgroups at the Sample Means of all Variables in 1958-1980 $(\bar{e}_{ij}, \bar{E}_i)$ and Sample Mean Average Budget Shares $(\bar{w}_j)$

i \ j	1	2	3	4-5	6	7	8	9	10	11	12	13-14	15	16	17	18	19	20	21	22	23-24	$\bar{E}_i$
1 Rice	.509	.017	.046	.043	.030	.052	.017	.013	.016	.019	.020	.019	.023	.026	.057	.028	.012	.024	.007	.033	.143	-1.155
2 Other cereals	-.015	-.084	-.009	-.008	-.006	-.010	-.003	-.002	-.003	-.004	-.004	-.004	-.004	-.005	-.011	-.005	-.002	-.004	-.001	-.006	-.027	.215
3 Fish	.009	.002	.053	.005	.003	.006	.002	.001	.002	.002	.002	.002	.003	.003	.006	.003	.001	.003	.001	.004	.016	-.127
4-5 Meat, Milk, etc.	-.070	-.016	-.041	-.425	-.027	-.047	-.015	-.012	-.015	-.017	-.018	-.017	-.021	-.023	-.051	-.025	-.011	-.021	-.006	-.030	-.128	1.016
6 Vegetables	-.014	-.003	-.009	-.008	-.086	-.010	-.003	-.002	-.003	-.003	-.004	-.004	-.004	-.005	-.011	-.005	-.002	-.004	-.001	-.006	-.027	.215
7 Processed food	-.025	-.006	-.015	-.014	-.010	-.156	-.005	-.004	-.005	-.006	-.007	-.006	-.008	-.008	-.018	-.009	-.004	-.008	-.002	-.011	-.046	.372
8 Cakes	-.047	-.010	-.027	-.026	-.018	-.031	-.267	-.008	-.010	-.011	-.012	-.011	-.014	-.015	-.034	-.017	-.007	-.014	-.004	-.020	-.085	.689
9 Fruits	-.071	-.016	-.041	-.039	-.027	-.047	-.015	-.402	-.015	-.017	-.019	-.017	-.021	-.023	-.052	-.025	-.011	-.021	-.006	-.030	-.129	1.045
10 Beverages	-.094	-.021	-.055	-.052	-.037	-.063	-.020	-.016	-.539	-.023	-.025	-.023	-.028	-.031	-.069	-.034	-.015	-.028	-.008	-.040	-.172	1.392
11 F.a.f.h.	-.093	-.021	-.055	-.051	-.036	-.062	-.020	-.016	-.019	-.537	-.024	-.023	-.028	-.031	-.068	-.034	-.015	-.028	-.008	-.039	-.170	1.378
12 Rent	-.078	-.017	-.046	-.043	-.030	-.052	-.017	-.013	-.016	-.019	-.449	-.019	-.023	-.026	-.057	-.028	-.012	-.023	-.007	-.033	-.142	1.149
13-14 Repairs + water	-.043	-.010	-.025	-.024	-.017	-.029	-.009	-.007	-.009	-.010	-.011	-.248	-.013	-.014	-.031	-.016	-.007	-.013	-.004	-.018	-.079	.637
15 Furniture	-.100	-.022	-.059	-.055	-.039	-.067	-.022	-.017	-.021	-.024	-.026	-.025	-.587	-.033	-.074	-.036	-.016	-.030	-.009	-.043	-.184	1.492
16 Fuel + light	-.084	-.019	-.050	-.046	-.033	-.056	-.018	-.014	-.018	-.020	-.022	-.021	-.025	-.495	-.062	-.030	-.013	-.026	-.007	-.036	-.154	1.250
17 Clothes	-.068	-.015	-.040	-.037	-.026	-.045	-.015	-.012	-.014	-.016	-.018	-.017	-.020	-.023	-.425	-.024	-.011	-.020	-.006	-.029	-.124	1.004
18 Personal effects	-.034	-.008	-.020	-.019	-.013	-.023	-.007	-.006	-.007	-.008	-.009	-.008	-.010	-.011	-.025	-.201	-.005	-.010	-.003	-.014	-.062	.506
19 Medical care	-.106	-.023	-.062	-.058	-.041	-.070	-.023	-.018	-.022	-.025	-.028	-.026	-.032	-.035	-.077	-.038	-.600	-.032	-.009	-.045	-.193	1.563
20 Toilet care	-.048	-.011	-.028	-.026	-.018	-.032	-.010	-.008	-.010	-.011	-.012	-.012	-.014	-.016	-.035	-.017	-.007	-.277	-.004	-.020	-.087	.704
21 Transportation	-.160	-.036	-.094	-.088	-.062	-.107	-.034	-.027	-.033	-.039	-.042	-.040	-.048	-.053	-.117	-.058	-.025	-.048	-.900	-.068	-.293	2.373
22 Education	-.013	-.003	-.008	-.007	-.005	-.009	-.003	-.002	-.003	-.003	-.004	-.003	-.004	-.004	-.010	-.005	-.002	-.004	-.001	-.080	-.025	.199
23-24 Tobacco + recreation	-.099	-.022	-.058	-.054	-.038	-.066	-.021	-.017	-.020	-.024	-.026	-.024	-.030	-.033	-.072	-.036	-.015	-.030	-.008	-.042	-.726	1.462
$\bar{w}_j$	.047	.016	.038	.060	.029	.052	.020	.019	.029	.034	.031	.022	.046	.042	.079	.030	.025	.028	.051	.031	.272	

$\bar{e}_{ij}$ = elasticity of subgroup i with respect to the j^{th} price calculated at sample means

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

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

Table 11. Estimated Money Flexibility $\check{\omega}^e$ by the Sample Period in Recent Years

Period \ s_t variable	$s_t = m_{t-1} - m_{t-2}$	$s_t = (m_{t-1} - m_{t-2})/m_{t-2}$
1952 - 1980	-1.320	-1.295
1958 - 1980	-2.679	-2.528
1959 - 1980	-3.225	-3.051
1960 - 1980	-3.050	-2.919
1961 - 1980	-3.083	-2.993

$\check{\omega}^e = 1/\hat{\phi} = -\bar{m}/\hat{\lambda}$, $-\varphi = (m - \Sigma_i p_i \beta_i)/m$

Subgroups of meat, milk and eggs; repairs and water charges; and of tobacco and recreation are further aggregated into a single group, respectively.

Table 12. Estimates of Cost of Living Index and Subsistence Cost by Year in 1958-1980

Year	Cost of living index	Subsistence cost	Year	Cost of living index	Subsistence cost
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			

Cost of living index in 1958 = 100.0

Subsistence cost = $\Sigma_i p_{it} \hat{\beta}_{it}$

Figures in parentheses indicate cost of living indeces with that of 1960 being equal to 100.0

estimates of income and price elasticities for 21 subgroups of commodities and their sample mean average budget shares, with the use of Engel aggregation, Cournot aggregation and homogeneity condition.[11] Table 13 shows the derived income and price elasticities and average budget shares for food and nonfood in the three sample periods. The derived estimates for the 1960–80 period[12], which were drawn similarly, are not given in Table 13, but they are found to be similar to the 1958–80 results.

The derived demand elasticities varied across the sample periods. Especially income and price elasticities for food have been diminishing in absolute terms over time. It is well 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 possessed by the linear expenditure system.[13] 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, being interpretable as subsistence consumption levels.

According to the analysis of the 21-commodity breakdown, all estimates of β_{it} were positive values in the three selected subperiods and in the subperiod 1960–80, where own price elasticities were all less than 1 in absolute value. Meanwhile, the income elasticity was particularly high for such nonfood subgroups as transportation, medical care, furniture and recreation during the whole period under observation. Rent and fuel and light exhibited an upward tendency in income elasticity. It is unquestionable that larger and high-quality housing continues to be in great demand. At the same time, beverages, food away from home, fruits and meat assume high income elasticities.

It is clear that those commodity groups with high income elasticity have been rising in the relative position of total expenditure. Rice and other cereals, which have a negative or low income elasticity, dropped remarkably in the share of consumer's budget. As a result, income is considered the most important factor in allocating the total budget among different commodities.

A brief illustration of the changes in prices and their influence on the consumption patterns may be useful. Let us take the 1958–80 period, 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 the CPI rose 4.4 times. Other subgroups of food commodities have advanced relatively slowly in current price. Of nonfood subgroups, education and repairs each went up 8 times, and rent advanced 6 times in price. Increases in other prices were relatively small.

A sharp drop was not observed in the expenditures in constant prices on fish, vegetables, food away from home, rent, education, etc. whose prices jumped markedly. It suggests that consumption was affected more by income than by relative prices. Except food away from home and rent, the above subgroups seem to have ceased to grow in per capita consumption.

As is well recognized, money flexibility estimates are sensitive to the differences in the sample period, commodity classification, model specification, whether it is a static or dynamic version, the type of the proxy variable for changing tastes and so on. According to the results with the same commodity classification and model specification, there is an 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 span of time. Thus, money flexibility is to a large extent associated with the substitutability between

Table 13. Demand Elasticities and Average Budget Shares for Food and Non-food Derived from the Results for Three Different Cases of Twenty-one Commodity Breakdown

Period	1951 - 1961			1960 - 1977			1958 - 1980		
i \ j	1	2	$\overline{E}_i$	1	2	$\overline{E}_i$	1	2	$\overline{E}_i$
1 Food	-.36	-.20	.56	-.32	-.15	.47	-.29	-.15	.44
2 Non-food	-.53	-.83	1.36	-.36	-.92	1.28	-.37	-.92	1.29
$\overline{w}_j$	.454	.546		.350	.650		.344	.656	

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

$\overline{e}_{ij}$ = elasticity of group i with respect to the $\underline{j}^{th}$ price calculated at sample means

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

$\overline{w}_j$ = budget share of group j calculated at sample means commodities. For the above reasons, the authors agree with the assertion that too much emphasis should not be placed on the welfare aspect of money flexibility.[14]

Speaking of some striking characteristics of the demand patterns in the 1950's, the early stage of the postwar period, the Japanese traditional dietary habits prevailed, with an increased per capita consumption of rice and fish and with less consumption of barley and other miscellaneous grains. Food away from home and animal protein food like milk and eggs possessed very high income elasticities. In view of the highly income-elastic demand for furniture and repairs (and equipment), it can be said that people had a growing interest in housing facilities.

In the 1960's and the 1970's, per capita consumption of rice dropped widely while meat, fruits, beverage and food away from home were in good demand. Other cereals turned to normal goods as bread, noodles, etc. became popular. Milk and eggs ceased to grow at a rapid rate. Apart from food consumption, there was such a great rush upon private cars that transportation gained twice as much as the 1951–61 level in income elasticity, with the advance of motorization in daily life. Rent also showed a noticeable rise in income elasticity, as well as fuel and light, indicating that there is a strong demand for more spacious and comfortable housing. Clothes, personal effects and toilet care became less elastic with respect to income. It would imply that the demand for these items is met relatively well. Moreover, education is inelastic with respect to income and prices. Income elasticities of recreation, toilet care and beverages remained relatively constant at high levels throughout the whole period.

The introduction of the taste variable into the expenditure functions served to obtain a good fit in the regression of the linear expenditure system to long time series. The lagged increase in deflated income and lagged rate of increase in deflated income are found effective in structuring a dynamic system of consumer demand, in particular for the periods of slow and moderate economic growth when consumers take a prudent attitude in the purchasing.

6. CONCLUDING REMARKS

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

It is very important to identify the effect of dynamic factors as well as all the effects of income and price changes in analyzing the actual situation of consumer demand over a long period of time. For this purpose, a proxy for changing tastes was incorporated into the expenditure system. In consequence, the incorporation of a taste variable had the advantages of obtaining fairly good regression results and more stable demand and utility parameters. The taste variable in this study is delineated in terms of an annual increment in deflated income or its annual rate of growth.

In later subperiods, lagged annual increase in deflated income and its lagged annual rate of growth were used instead of current ones, and they proved effective in achieving valid results of regressions. It gives an account of a structural change of demand in which consumers became modest in their needs and responded to an annual increase in real income with a lag.

Consumption patterns are considered to have changed substantially toward more Westernized style of life and eating habits since the end of the 1950's or the beginning of the 1960's. In regard to per capita food consumption, rice and fish went down with increases in deflated income, whereas animal protein food, fruits and beverages increased rapidly. Food away from home continued to increase greatly. As for nonfood consumption, private transportation practically became a thing of daily necessity. There is a growing demand for roomy and more pleasant residences. It is possible that people's view of education has been changing slightly and may be gradually diversified in various ways.

The dynamic factors affecting tastes could be specified in a more appropriate way, although the estimation problem would become much more complex. As a matter of fact, it turned out in our models that variations in expenditure on each commodity can be explained to a large extent in terms of changes in both income and prices. Moreover, it is noteworthy that the taste variable had the effect of stabilizing the demand system as a whole and considerably reduce 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 in inverse proportion to estimated money flexibility, which has a close relation to price elasticities. High values of money flexibility were obtained at the lower levels of per capita income in the early years of the observation period. This implies that own price elasticities were small with rather limited substitutabilities between different commodities. In the times of rapid economic growth, money flexibility estimates dropped to some extent and, recently, they rose appreciably reflecting the less responsive consumer demand with respect to price changes.

Since β_{it} estimates have been found to be positive values in many cases, demand for respective subgroups tends to be price-inelastic and cross price elasticities came out negative in sign between normal goods. The derived price elasticities of food and nonfood were smaller than 1 in absolute value. Those elasticities of food demand with respect to income and own price have been on the decrease over time across sample periods.

Marginal budget shares of many subgroups have changed by varying degrees during the whole period. Transportation, recreation and rent showed a notable upward shift in those shares and, on the other hand, rice consumption declined remarkably with its reduced share in marginal terms. There are only three subgroups which remained relatively constant in marginal budget share, namely beverages, food away from home, and medical care.

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

NOTES

1. It 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's, is described as

$$p_i x_i = p_i \overline{x}_i + \alpha(\overline{w}_i \Sigma_j p_j \overline{x}_j - p_i \overline{x}_i) + b_i(m - \Sigma_j p_j \overline{x}_j) + c_i s,$$
$$(i, j = 1, 2, \cdots, N).$$

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 sample means of all variables.

3. The simple error structure is assumed as follows. All expected values of errors are equal to zero. There are no cross equation correlation and no serial correlation. Errors for each equation are subject to homoscedasticity (see Sasaki, 1982).

4. First, in the case that 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 brought to an end. Third, when the estimate of λ is very small or, in other words, when the estimate of money flexibility $\check{\omega}$ is extremely high, the result seems invalid because price effects are liable to fail.

These cases are all excluded from our discussion.

5. See Powell, Hoa and Wilson, 1968, and Lluch and Williams, 1975.

This study takes a nonlinear approach by linear models for many short time series of the whole period under consideration, as was suggested in Lluch and Williams, 1975.

6. The $R_{y'.us}$ indicates the multiple correlation coefficient of the estimating equation where the dependent variable for the i^{th} subgroup is y'_i ($y'_{it} = p_{it}x_{it} - p_{it}\overline{x}_{it} - \hat{\lambda}z_{it}$), and the independent variables are u and s. The 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. There is the following relation between own price elasticity $\overline{e}_{ii}$ and income elasticity $\overline{E}_i$ at sample means (see Sasaki, 1982):

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

The first term on the right-hand side usually predominates over the second terms, especially for finely defined commodities. It may be well said, therefore, that own price elasticity is proportional to income elasticity and is 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 is also described as

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

where $\overline{\beta}_i$ denotes the subsistence parameter of the i^{th} commodity, evaluated at sample means. As far as $\overline{\beta}_i$ is positive in sign, own price elasticity $\overline{e}_{ii}$ is greater than -1, and if $\overline{\beta}_i$ is negative, $\overline{e}_{ii}$ 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

$$\begin{aligned}\alpha_{ij} &= (\partial X_i/\partial p_j)u\_ \cdot (p_j/x_j)/w_j \\ &= (e_{ij}/w_j) + E_i \quad (i \neq j),\ (i,j = 1, 2, \cdots, N),\end{aligned}$$

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

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

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 α_{ij}'s are set equal to a constant α in Leser's system.

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

$$C_{ot} = (1 + \varphi)(\Sigma_i P_{it}\beta_{it} / \Sigma_i P_{io}\beta_{it}) - \varphi\Pi_i(P_{it}/P_{io})^{b_i}$$
$$(t = 0, 1, 2, \cdots, T-1)$$

p_{it} and p_{io} indicate the i^{th} price in the comparison and base years respectively. The β_{it} is calculated by the following equation, using the estimates of b_i, c_i, and λ, and observed data.

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

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

$\Sigma_i \overline{w}_i \overline{E}_i = 1$ (Engel aggregation)

$\Sigma_i \overline{w}_i \overline{e}_{ij} = -\overline{w}_j$ (Cournot aggregation)

and

$\Sigma_j \overline{e}_{ij} = -\overline{E}_i$ (homogeneity condition)

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

12. The derived demand elasticities and sample mean average budget shares for the subperiod 1960–80 are as follows:

i	j	1	2	$\overline{E}_i$
1	Food	–.27	–.17	.44
2	Nonfood	–.38	–.91	1.29
	$\overline{w}_i$	.339	.661	

The notation and format are the same as in Table 13.

13. 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 expressed in the form:

$\overline{e}_{ij} = -b_i \overline{p}_j \beta_j / (\overline{p_i x_i})$, $(i, j = 1, 2, \cdots, N; i \neq j)$

which are evaluated at sample means.

14. For a detailed discussion in this respect, see Lluch and Powell (1975).

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