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LIFE-CYCLE CHANGES IN CONSUMPTION BEHAVIOR: AGE-SPECIFIC AND REGIONAL VARIATIONS*

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ABSTRACT: While research conducted over the last two decades has pointed to the important role played by household consumption in regional economic models, little attention has been directed to the consumption impacts associated not only with income changes, but also life-cycle changes. Using Japanese data, this paper explores some of the implications of life-cycle changes on consumption behavior using a modified AIDS (Almost Ideal Demand System) estimation system. Testing is directed to differences in age-specific consumption behavior and the potential differences in consumption by age and province.

1. INTRODUCTION

Research over the last two decades has highlighted the important role that households play in the economic development of a regional economy. Early research revealed that the set of important analytical elements in extended input-output and social accounting models was dominated by consumption expenditure patterns (see Hewings, 1982; Hewings et al., 1989). More recently, data have been assembled to explore various facets of income distribution at the national and regional levels (Li et al., 1999; Rose and Li, 1999), to explore the nature and magnitude of transboundary income flows (Kilkenny and Rose, 1995; Rose and Stevens, 1991) and to develop estimates of interrelation income multipliers (Rose and Beaumont, 1988, 1989; Rose and Li, 1999), using the formulations proposed by Miyazawa (1968, 1976). However, very little of this work has made its way into regional and interregional general equilibrium models. In addition, the influence of demographic change, one of the most important factors that affect the consumption structure of the household sector, has rarely

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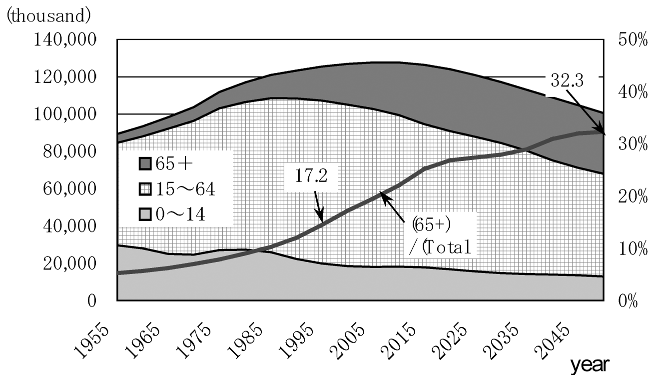


FIGURE 1: Demographic Transition in Japan.

been considered even in the context of an aging population. A recent projection of Japanese population reveals that although the total population has already started to decline, the elderly population is still increasing in both numbers and as a percentage of the total population (National Institute of Population and Social Security Research, 2002). This has caused a dramatic rising trend in the elderly population ratio, defined as the population over 65 years old divided by the total population. Figure 1 provides graphical evidence of the aging process in Japan; it can be seen that the elderly population ratio is increasing such that it will reach more than 32 percent at the end of the first half of this century. This means almost one third of the total population will be more than 65 years old at that time.

It is generally accepted that consumption behavior of a household changes according to stage in the life cycle. Figure 2 provides some empirical evidence again for Japan. Here the horizontal axis indicates life-cycle stages of households; each line shows the average share of expenditures for a specific generation, with households grouped by the year of their household head's birth. The profile of each line indicates changes in consumption behavior across the life cycle while the shifts of lines provide an indication of the changes in consumption behavior by generation.

Looking at these figures, one can observe the greater generational changes in the transportation budget share, especially in the earlier life stage. The data include expenses for automobiles in transportation expenditure. For example, consider the households group H, whose household heads were born in the 1930s; a car was an extraordinarily luxury good when they were in the earlier life stage, and it was not common for the young households to possess a car. However, it is quite common now to own cars even though these households are relatively young. Factors such as these create the potential for large generational shifts in Figure 2.

On the other hand, expenditure on education has a characteristic peak in the curve with the peak appearing later in the 40s of each generation. Note

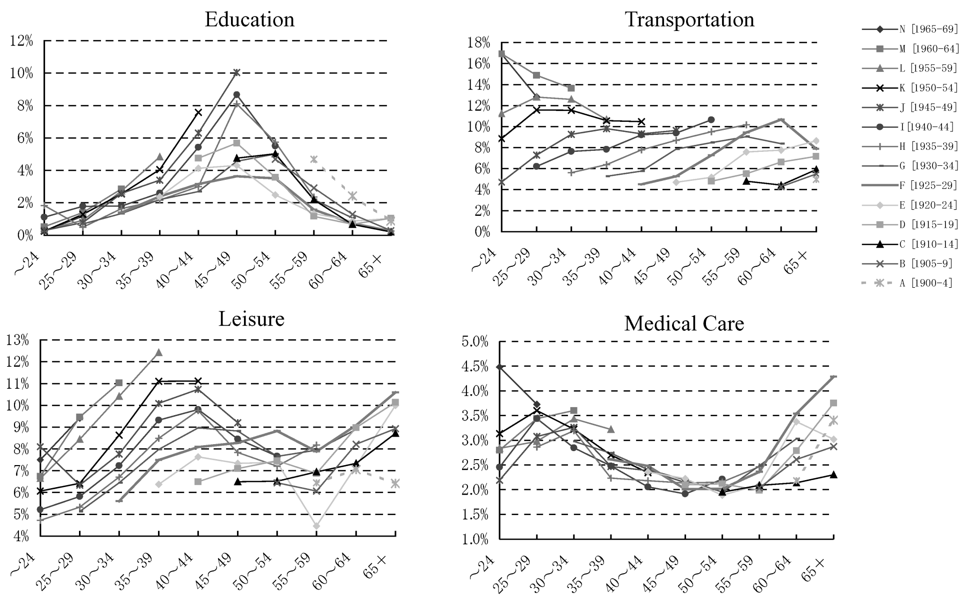


FIGURE 2: Life Cycle Changes in Budget Shares of Households' Consumption.

that the younger generation has the higher peak. This change across a household's life cycle accords with school-aged children in a household. Generally, a household in the age of 40s and 50s has a child or children of school age in an institution of higher education. The new generations spend more than the elderly did in the past because the ratio of children who go on to the next stage of education has increased.

In contrast, medical care is greater at the beginning and later on in households' life-cycle stages. In addition, it has a larger variation among generations in their young or elderly life stages.

The data in Figure 2 reveal how the households' consumption behaviors change across their life-cycle stages. With the demographic changes noted earlier, the consumption behavior of elderly becomes more and more important. Therefore, it is important to account for differences in consumption behavior in any long-term structural analysis of the economy.

In this paper, the main focus is a shift in a household's intra-temporal preference across its life-cycle stage. Fixed effects as parameter shifts of the demand system are introduced to capture this effect. This paper is organized into six sections. After this section, we introduce the Almost Ideal Demand System (AIDS) model to analyze households with age characteristics. The data used for the analysis are explained in Section 3. In Sections 4 and 5, the estimation results and implications using Japanese household data are presented. In the final section, the remaining problems in the analysis are reviewed and some guide is provided in the way these findings will be incorporated in multiregional models of the Japanese economy.

2. MODEL

The model used is based on AIDS, which was proposed by Deaton and Muellbauer (1980). This system is derived from the PIGLOG-class expenditure function defined as follows:

$$\ln c(u, p) = (1 - u)\ln a(p) + u \ln b(p) \tag{1}$$

where

$$\ln a(p) = \alpha_0 + \sum_k \alpha_k \ln p_k + \frac{1}{2}\sum_k \sum_j \gamma^*_{kj} \ln p_k \ln p_j \tag{2}$$

$$\ln b(p) = \ln(p) + \beta_0 \Pi_k p_k^{\beta_k} \tag{3}$$

Applying Shepherd's lemma to this expenditure function results in the following demand system:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \ln p_j + \beta_i \cdot \ln(x/P) \tag{4}$$

where w_i is the budget share of the ith good for the household, p_i is the price of good i, and (x/P) is the total expenditure on all goods and services in real terms, with a price index P defined by

$$\ln P = \alpha_0 + \sum_k \alpha_k \ln p_k + \frac{1}{2}\sum_j \sum_k \gamma_{kj} \ln p_k \ln p_j \tag{5}$$

where

$$\gamma_{ij} = \frac{1}{2}(\gamma^*_{ij} + \gamma^*_{ji})$$

Since the price index P is defined as equation (5), the original AIDS model is a nonlinear system. Deaton and Muellbauer (1980) suggested using the Stone price index,$\hat{P}$ instead of the "real" price index P to transform the system to a linear one.

$$w_i = \alpha_i + \sum_j \gamma_{ij} \ln p_j + \beta_i \cdot \ln(x/\hat{P}) \tag{6}$$

$$\ln \hat{P} = \sum_k w_k \ln p_k \tag{7}$$

This approximation makes the estimating process much easier, so that many application studies follow this procedure (however, see Buse, 1994 for a discussion of some of the limitations associated with the linearized version of the AIDS system and Cooper and McClaren, 1992 for some additional empirical issues).

To be consistent with the consumption theory, demand functions are required to satisfy the following conditions:

a) Adding up:

$$\sum_i \alpha_i = 1, \quad \sum_i \gamma_{ij} = 0, \quad \sum_i \beta_i = 0 \tag{8}$$

b) Homogeneity:

$$\sum_j \gamma_{ij} = 0 \tag{9}$$

c) Symmetry:

$$\gamma_{ij} = \gamma_{ji} \tag{10}$$

Since the AIDS formulation has a flexible specification, the system is not guaranteed to assure the homogeneity and symmetry conditions by itself. These are testable properties of this model. Testing regularity conditions of the demand system is not the primary focus of the present study, so that these conditions were introduced as parameter restrictions in the estimation process. This means these properties are satisfied by parameter restrictions in our model.

It was assumed that the size of the family affects budget share and hence n, the number of household members, was introduced as a shift parameter of α_i. Accordingly, the basic model with this correction is described as equation (11),

$$w_i^{kl} = \alpha_i + e_i \cdot n^{kl} + \sum_j \gamma_{ij} \ln p_j^{kl} + \beta_i(\ln x^{kl} - \ln \hat{P}^{kl}) + \varepsilon_i^{kl} \tag{11}$$

where ε_i^{kl} denotes error term of the model. The letters k and l refer to age group and region, respectively, since the data are also available by region for Japan.

Given the data structure, the error term of the model can be decomposed into three components: (1) age-specific fraction (μ^k), (2) region-specific fraction (ν^l), and (3) the rest (ζ^{kl}). ζ^{kl} is assumed to be independent and identically distributed.

$$\varepsilon_i^{kl} = \mu_i^k + \nu_i^l + \zeta_i^{kl} \tag{12}$$

Table 1 summarizes the error structure of the model (11), comparing the means of the error term (ε) by age groups. The reference group is G1, the average of all households. From G2 to G6 are age groups where households are categorized according to household head's age into under 29 (U29), 30–39 (30s), 40–49 (40s), 50–59 (50s), and more than 60 years (60+), respectively. A negative sign in shaded cells indicates that the average of ε in this age group is smaller than that of the reference group (G1), and the number in parenthesis denotes the statistical significance level of the difference between these two groups. The last row (BP) denotes the results of the Breusch–Pagan test. This tests the heteroskedasticity of the error term under the null hypothesis, H_0, that the variance of the error (σ^2) is constant over observations, against the alternative

TABLE 1: Age-Specific Fraction in Error Term

	FD	LS	EG	FN	MD	TS	CM	ED	OT	HS	TX
G2	−0.29	0.20	−0.16	−0.01	0.07	0.40	0.07	0.00	−0.12	−0.13	0.20
	(77.5%)	(84.5%)	(86.9%)	(99.0%)	(94.2%)	(69.0%)	(94.2%)	(99.9%)	(90.8%)	(89.8%)	(84.5%)
G3	−0.09	0.39	−0.12	0.07	0.32	0.18	−0.09	−0.25	−0.21	−0.02	0.24
	(93.1%)	(69.6%)	(90.3%)	(94.8%)	(75.0%)	(85.8%)	(92.8%)	(80.6%)	(83.8%)	(98.7%)	(80.8%)
G4	0.19	0.05	0.06	−0.15	−0.04	−0.14	0.07	0.34	−0.34	0.13	0.01
	(84.9%)	(95.9%)	(95.1%)	(88.4%)	(96.7%)	(89.2%)	(94.0%)	(73.4%)	(73.4%)	(90.0%)	(99.0%)
G5	−0.15	−0.12	−0.03	0.07	−0.20	0.10	0.17	−0.15	0.23	−0.09	0.05
	(88.4%)	(90.3%)	(97.9%)	(94.7%)	(83.8%)	(92.1%)	(86.1%)	(87.9%)	(81.8%)	(93.0%)	(96.3%)
G6	0.19	0.12	0.16	0.05	0.27	−0.22	−0.09	−0.15	−0.43	0.42	−0.37
	(85.0%)	(90.4%)	(87.1%)	(96.3%)	(78.5%)	(82.9%)	(92.8%)	(88.0%)	(66.7%)	(67.8%)	(71.2%)
BP	Rejct.	Rejct.	Rejct.	Rejct.	Rejct.	Rejct.	Rejct.	Rejct.	Rejct.	Rejct.	Rejct.

T-test statistics, which examine differences in mean values of the error term between two groups (G2–G6 and G1, the average of all households).
$\left(\bar{\varepsilon}_i^k - \bar{\varepsilon}_i^{ave}\right)/\sqrt{\sigma_i^k/n - \sigma_i^{ave}/m}$, where n, m mean number of the sample in each group.
A number in parentheses denotes significance level.
Rejct. refers to rejecting the null hypothesis.

hypothesis, H_1, that σ^2 is a function of the age dummy. The results show that the null hypothesis is significantly rejected in every equation, implying that the age categorization is important.

To deal with these age-specific fractions, fixed age effects were introduced into the model; the following equations denote the correction of the model regarding age effects:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \ln p_j + \beta_i(\ln x - \ln \hat{P}) + u_i \tag{13}$$

where

$$\alpha_i = \alpha_{i0} + e_i n + \sum_k \alpha_{ik} Dage_k$$

$$\beta_i = \beta_{i0} + \sum_k \beta_{ik} Dage_k$$

and where $Dage_k$ is a dummy variable for age group k.

The system described in (13) allows parameters α and β to shift as a household moves into a new life-cycle stage. With consideration of age variations, theoretical conditions given by equations (8) to (10) are rewritten as follows:

1) Adding up

$$\sum_i \alpha_{i0} = 0, \sum_i e_i = 0, \sum_i \alpha_{ik} = 0 \quad \text{(for all } k = 2, \ldots, 6 \text{ (age dummies))}$$

$$\sum_i \gamma_{ij} = 0, \sum_i \beta_{i0} = 0, \sum_i \beta_{ik} = 0 \quad \text{(for all } k = 2, \ldots, 6 \text{ (age dummies))}$$

2) Homogeneity

$$\sum_j \gamma_{ij} = 0$$

3) Symmetry

$$\gamma_{ij} = \gamma_{ji}$$

3. DATA

In this section, the data used in the following analyses are described briefly. The data source for the consumption expenditure of households is the national survey of family income and expenditure in Japan, which is conducted every 5 years. These survey data were pooled for the four sets of observations made between 1984 and 1999. Consumption goods and services are aggregated into 11 categories: food (FD), clothing (TX), housing (HS), energy (EG), furniture (FN), medical care (MD), transportation (TS), communication (CM), leisure (LS), education (ED), and miscellaneous (OT). There are also divisions into 47 provinces and every province has the collection of each 5-year age group: under

24, 25–29, 30–34, 35–39, 40–44, 45–49, 50–54, 55–59, 60–64, 65–69, 70–74, over 75 years, and the average for all ages.

Table 2 summarizes the budget share of each consumption good and service by age group. Households are classified into six age groups: under 29 (U29), 30–39 (30s), 40–49 (40s), 50–59 (50s), over 60 (60+), and the average for all groups. On average, U29 spend more on transportation, communication, and medical care, and less on food and education. Similarly, those in their 30s spend more on leisure, and less on housing. While the households in their 40s spend more on education, they spend less on medical care and communication. The standard deviation is higher in U29 than in other age groups, reflecting the fact that the young households' consumption behavior varies among different regions as well as among different years. Furthermore, it may reflect the influence of the decade-long recession that has existed in Japan for much of the 1990s.

As for the price data, the regional consumer price indices were estimated by following formula:

$$R\_CPI_i^l = N\_CPI_i \times RD_i^l \tag{14}$$

where N_CPI_i is a national consumer price index of good i and RD_i^l is a regional differential index of good i in region l, scaled to the national average as 1.00.

Table 3 summarizes the statistical characteristics of the regional price indices. The overall deviation is larger in education (ED), housing (HS), and clothing (TX), and smaller in transportation (TS) and furniture (FN). The deviation among regions is larger in housing and education, and smaller in medical care (MD) and communication (CM) while the deviation among regions increases greatly in education and housing, and slightly less so in clothing, furniture, and miscellaneous (OT) over time. From these results, it can be inferred that prices are different from region to region, even in the same year. However, the reasons for these deviations vary by category.

For example, the regional deviation in housing price indices is caused by great differentials in land values. On the other hand, the regional deviation in education price indices comes from differentials in enthusiasm for children's education, or the availability of public services. Roughly speaking, parents in urban areas have a higher propensity to provide their children with a higher education and are more eager to spend on additional education services, which are private and mostly expensive. In addition, urban areas have more school-aged children than the quota of public schools. For this reason, some of the children receive education services from private schools, which are more expensive than public services in most cases. These attitudes lead to a higher education price index in an urban area, and consequently generate price disparities among regions.

A significant shift of the mean over time is observed for education, medical care, and clothing. For example, the mean of the price indices of education services increased by 4 percent per year from 1984 to 1994, and by 2 percent from 1994 to 1999. On the other hand, the regional deviation in medical care is relatively small. Therefore, deviations across time are by far the more dominant

TABLE 2: Summary of Households' Expenditure Data

		Average	U29	30s	40s	50s	60+
Sample	2431	188	363	376	376	376	752
Wfd	Mean	19.50	18.62	20.88	20.34	17.35	19.92
	Std. Dev.	(1.863)	(3.846)	(2.585)	(2.444)	(1.898)	(2.534)
Wls	Mean	10.90	12.75	13.57	11.18	8.93	10.23
	Std. Dev.	(0.910)	(3.885)	(1.463)	(1.847)	(1.261)	(2.109)
Weg	Mean	5.14	5.75	5.56	5.11	4.68	5.47
	Std. Dev.	(0.544)	(1.312)	(0.632)	(0.651)	(0.572)	(0.919)
Wfn	Mean	3.44	3.66	3.51	3.14	3.46	3.64
	Std. Dev.	(0.414)	(1.633)	(0.643)	(0.627)	(0.924)	(1.064)
Wmd	Mean	2.57	3.73	3.04	2.12	2.17	3.32
	Std. Dev.	(0.381)	(2.941)	(0.782)	(0.442)	(0.484)	(1.207)
Wts	Mean	7.38	10.72	8.79	7.25	7.16	5.55
	Std. Dev.	(0.891)	(5.699)	(2.705)	(1.656)	(1.785)	(2.399)
Wcm	Mean	2.20	2.91	2.28	2.10	2.20	2.33
	Std. Dev.	(0.400)	(1.393)	(0.709)	(0.519)	(0.391)	(0.420)
Wed	Mean	3.70	1.08	3.76	6.50	2.75	1.02
	Std. Dev.	(0.953)	(1.334)	(0.985)	(1.861)	(2.205)	(0.932)
Wot	Mean	23.80	19.76	18.81	21.87	29.61	21.93
	Std. Dev.	(2.195)	(5.285)	(2.145)	(4.303)	(3.933)	(4.553)
Whs	Mean	15.97	15.17	14.10	14.97	16.21	21.81
	Std. Dev.	(1.851)	(4.865)	(2.611)	(1.975)	(2.391)	(3.931)
Wtx	Mean	5.40	5.86	5.70	5.42	5.47	4.77
	Std. Dev.	(0.847)	(2.177)	(0.886)	(0.959)	(1.216)	(1.479)

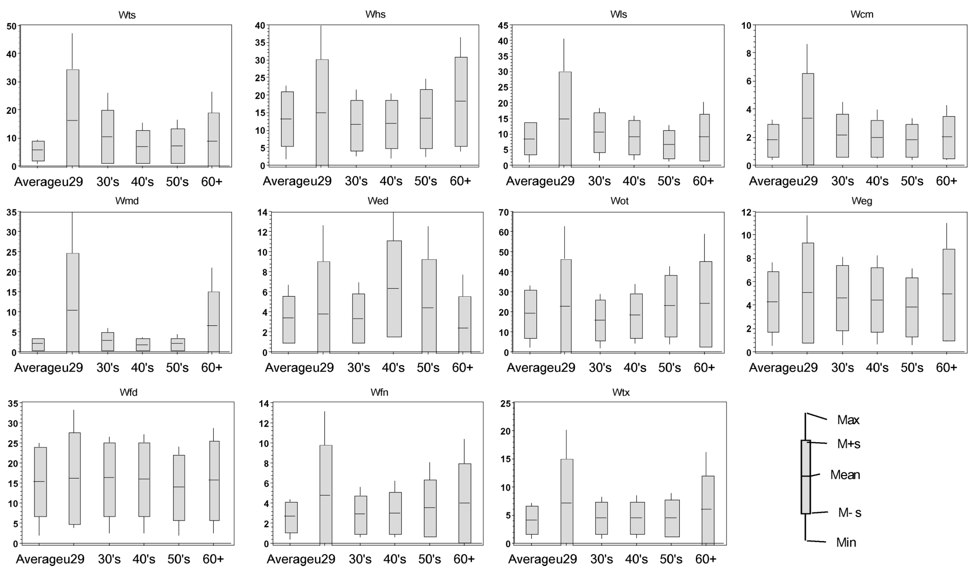
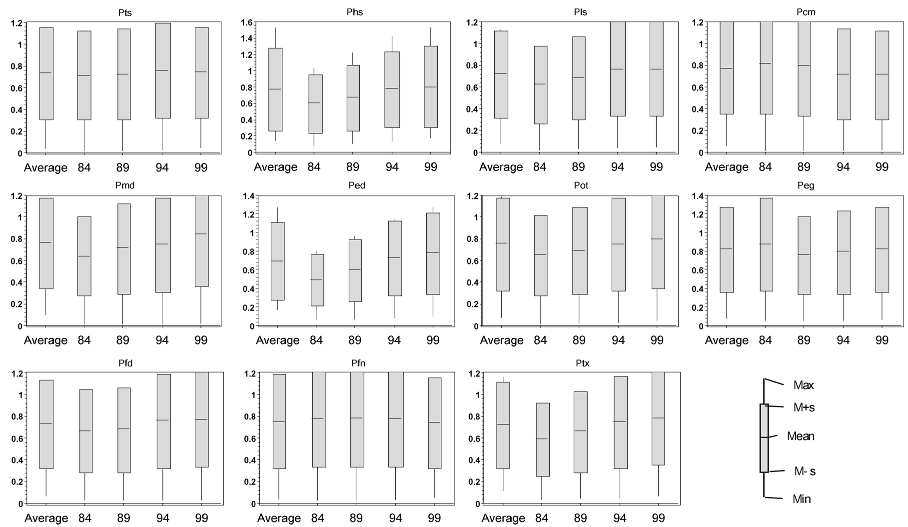


TABLE 3: Summaries of Regional Consumption Price Indices

		Pfd	Pls	Peg	Pfn	Pmd	Pts	Pcm	Ped	Pot	Phs	Ptx
Average	Mean	0.946	0.915	1.050	1.021	0.985	0.974	1.007	0.821	0.957	0.807	0.930
	Std. Dev.	(0.070)	(0.079)	(0.080)	(0.044)	(0.099)	(0.037)	(0.063)	(0.171)	(0.072)	(0.145)	(0.111)
84	Mean	0.871	0.817	1.135	1.030	0.853	0.958	1.081	0.613	0.869	0.711	0.788
	Std. Dev.	(0.026)	(0.024)	(0.055)	(0.025)	(0.012)	(0.023)	(0.016)	(0.062)	(0.016)	(0.078)	(0.031)
89	Mean	0.894	0.881	0.980	1.029	0.959	0.965	1.053	0.748	0.926	0.772	0.889
	Std. Dev.	(0.028)	(0.033)	(0.058)	(0.024)	(0.015)	(0.023)	(0.013)	(0.074)	(0.020)	(0.103)	(0.045)
94	Mean	1.002	0.984	1.034	1.042	1.003	1.010	0.949	0.915	0.994	0.863	0.998
	Std. Dev.	(0.030)	(0.038)	(0.058)	(0.034)	(0.014)	(0.029)	(0.017)	(0.075)	(0.031)	(0.134)	(0.050)
99	Mean	1.016	0.980	1.052	0.982	1.126	0.963	0.947	1.007	1.038	0.883	1.044
	Std. Dev.	(0.030)	(0.045)	(0.061)	(0.057)	(0.019)	(0.045)	(0.023)	(0.100)	(0.048)	(0.177)	(0.068)
Shift in mean	84–89	0.53%	1.50%	−2.89%	−0.02%	2.37%	0.15%	−0.51%	4.08%	1.29%	1.64%	2.43%
	89–94	2.30%	2.25%	1.08%	0.25%	0.90%	0.92%	−2.06%	4.10%	1.43%	2.26%	2.34%
	94–99	0.27%	−0.09%	0.35%	−1.17%	2.35%	−0.95%	−0.05%	1.94%	0.86%	0.47%	0.91%



factor in accounting for price differences. Prices of most goods and services increase over time but a price drop is observed in communication, furniture, and transportation. The fall in communication prices is sizable, considering that most regional deviations in the same year are small.

A further test, whose results are shown in Table A1 in the Appendix, explored the degree to which the regional price indices were significantly different from each other. In each year, the regional price indices were divided into two groups, upper and lower halves, and the test explored whether the means of each group came from the same population. The results indicate that they come from different populations: therefore, we can expect more appropriate results when the regional price indices are used.

4. EMPIRICAL RESULTS

Tables 4 to 6 summarize the estimation results of AIDS model with life-cycle effects. Here four versions were estimated of model (13):[1] (i) Full life-cycle model, (ii) Partial life-cycle model, omitting life-cycle effects on parameter α, (iii) Partial life-cycle model, omitting life-cycle effects on parameter β, and (iv) a model without life cycle, omitting life-cycle effects on both parameters (same as model 11). Iterated SUR was used for estimation, since the dependent variables in the model are budget shares of households' consumption and they are simultaneously correlated with each other because of the budget constraint. In addition, it is possible to use a number of samples as a weight variable to adjust sample size biases caused by survey data in which sample sizes are different.

Table 5 compares the estimated parameters, α and β, among these four models. The last row shows the ***F*** statistics to test the significance of life-cycle effects as a group.

In this test, the restricted model is one of the models (ii), (iii), or (iv) and the nonrestricted model is the full model (i). According to these results, the ***F***-test statistics support the statistical suitability of the full model compared with the other three models.

[1] We have 2432 observations. However, there are outliers in terms of their negative price elasticity of expenditure function ($\partial C/\partial p_i$). Among them, we consider one which price elasticity of transportation is negative (Saga, 1994, U29) as an outlier and eliminate this sample from observations. We also have 182 samples which price elasticity of education is negative (74 samples in 1984, 54 samples in 1989, 35 samples in 1994 and 19 samples in 1999). 33 regions have at least one with negative price elasticity of education. The largest number is Ehime (18 samples), the second largest is Okayama Yamaguchi (16 samples), the third largest is Okayama (14 samples), and so on.

However, most of them are younger than 29 or older than 60, except for one (Kagoshima, 1989 and 1984, 55-59). As we've seen before, budget share of education expenditure in these age groups is negligibly small because they do not have school-aged children. Although negative price elasticity is not theoretically acceptable, we regard the implications from this as negligible and include these observations in our estimation. As a consequence we use 2431 observations for our estimation.

TABLE 4: Estimation Results of AIDS (1)

			Life Cycle – Full Model		Without Life-Cycle Effect					
					$-\alpha$		$-\beta$		$-\alpha, \beta$	
	DF Model	DF Error	Adj R^2	MSE	Adj R^2	MSE	Adj R^2	MSE	Adj R^2	MSE
FD	18.5	2413	0.7134	0.0291	0.7064	0.0298	0.7070	0.0298	0.6292	0.0377
LS	18.5	2413	0.5519	0.0243	0.5069	0.0267	0.5071	0.0267	0.3535	0.0350
EG	18.5	2413	0.7197	0.0019	0.7168	0.0019	0.7168	0.0019	0.6639	0.0023
FN	18.5	2413	0.2472	0.0051	0.2482	0.0051	0.2476	0.0051	0.2428	0.0051
MD	18.5	2413	0.5436	0.0036	0.5430	0.0036	0.5430	0.0036	0.4771	0.0041
TS	18.5	2413	0.2337	0.0443	0.2061	0.0459	0.2049	0.0460	0.0017	0.0577
CM	18.5	2413	0.5439	0.0017	0.5418	0.0017	0.5417	0.0017	0.5133	0.0018
ED	18.5	2413	0.7251	0.0216	0.7056	0.0231	0.7027	0.0234	0.5609	0.0345
OT	18.5	2413	0.6352	0.0994	0.6209	0.1033	0.6216	0.1031	0.5124	0.1329
HS	18.5	2413	0.5534	0.0834	0.5276	0.0882	0.5308	0.0876	0.3509	0.1212

Parameters in the full model and their statistical significance are summarized in Table 6. A coefficient for the age dummy is used to assess the life-cycle effect in each age group.

For example, looking at theβ parameter in the leisure expenditure function, the coefficient of the 40s age group is significantly negative (–0.072), implying that the β parameter in this age group is significantly lower than the average. Since β_0 is estimated as 0.0015, the β parameter of leisure expenditure in 40s turns out to be negative ($0.0015 - 0.072 < 0$).

β is a coefficient of the real-income term ($\ln(x/\hat{P})$) in the model. A positive sign for this coefficient means that the good is a luxury good because its budget share goes up when income increases in real terms. In other words, income elasticity is greater than one. A negative coefficient means the opposite and a good is recognized as a necessity if β is negative.

β coefficients in leisure show that income elasticity in leisure expenditure is higher than one over most of the life cycle, except in the 40s. Pressure from education expenditures, described earlier, probably account for this exception, together with expenditures on housing.

Similarly, there are several goods whose signs for the β coefficients change through the household's life cycle. Transportation, housing, and education belong to this type of goods and services.

5. ECONOMIC IMPLICATIONS

Figures 3 and 4 indicate shifts of parameters α and β across a household's life cycle. The larger and positive β is, the smaller α tends to be. Therefore, most of the combinations of α and β locate in either left-high or right-low quadrants. The goods that appear in the left-higher box are categorized as luxury goods, because as already noted, a positive value for β indicates that the income elasticity of this good is greater than one. The goods that appear in right-lower box are necessities.

TABLE 5: Estimation Results of AIDS (2)

	Full Model			Without Effect on α, β			Without Effect on β			Without Effect on α		
	Estimate	T ratio	P value	Estimate	T ratio	P value	Estimate	T ratio	P value	Estimate	T ratio	P value
α												
FD	0.64382	(28.19)	0.0000	0.56139	(47.6)	0.0000	0.67921	(44.8)	0.0000	0.67917	(44.8)	0.0000
LS	0.12536	(5.87)	0.0000	0.41317	(35.91)	0.0000	0.15377	(10.43)	0.0000	0.15282	(10.37)	0.0000
EG	0.20832	(33.8)	0.0000	0.18755	(62.79)	0.0000	0.21759	(52.82)	0.0000	0.21837	(53.07)	0.0000
FN	0.07481	(7.65)	0.0000	0.06919	(15.63)	0.0000	0.07228	(11.19)	0.0000	0.07211	(11.18)	0.0000
MD	0.08730	(10.32)	0.0000	0.15285	(37.91)	0.0000	0.09997	(17.73)	0.0000	0.10091	(17.91)	0.0000
TS	0.06060	(2.19)	0.0290	0.14919	(10.37)	0.0000	−0.03260	(−1.77)	0.0769	−0.03451	(−1.87)	0.0616
CM	0.12514	(21.58)	0.0000	0.08726	(32.58)	0.0000	0.11449	(29.64)	0.0000	0.11459	(29.7)	0.0000
ED	−0.00126	(−0.07)	0.9475	−0.17307	(−15.66)	0.0000	−0.06235	(−4.81)	0.0000	−0.06329	(−4.92)	0.0000
OT	−0.31470	(−7.63)	0.0000	−0.66494	(−30.58)	0.0000	−0.41073	(−15.03)	0.0000	−0.41375	(−15.14)	0.0000
HS	−0.00316	(−0.09)	0.9300	0.18479	(9.22)	0.0000	0.17426	(7.45)	0.0000	0.18047	(7.7)	0.0000
TX	−0.00622			0.03263			−0.00588			−0.00689		
β												
FD	−0.08761	(−21.89)	0.0000	−0.07358	(−35.45)	0.0000	−0.09468	(−34.16)	0.0000	−0.09468	(−34.11)	0.0000
LS	−0.00150	(−0.4)	0.6885	−0.05960	(−29.5)	0.0000	−0.00836	(−3.11)	0.0019	−0.00837	(−3.11)	0.0019
EG	−0.02983	(−27.58)	0.0000	−0.02460	(−46.89)	0.0000	−0.03130	(−41.67)	0.0000	−0.03142	(−41.82)	0.0000
FN	−0.00761	(−4.43)	0.0000	−0.00546	(−7.02)	0.0000	−0.00726	(−6.15)	0.0000	−0.00724	(−6.13)	0.0000
MD	−0.00863	(−5.81)	0.0000	−0.01886	(−26.65)	0.0000	−0.01080	(−10.49)	0.0000	−0.01096	(−10.64)	0.0000
TS	0.00034	(0.07)	0.9440	−0.01848	(−7.3)	0.0000	0.01644	(4.86)	0.0000	0.01664	(4.92)	0.0000
CM	−0.01652	(−16.21)	0.0000	−0.01020	(−21.65)	0.0000	−0.01456	(−20.59)	0.0000	−0.01459	(−20.63)	0.0000
ED	0.00037	(0.11)	0.9127	0.02011	(10.34)	0.0000	0.01158	(4.89)	0.0000	0.01176	(4.98)	0.0000
OT	0.10683	(14.83)	0.0000	0.17145	(44.91)	0.0000	0.12493	(25.09)	0.0000	0.12542	(25.16)	0.0000
HS	0.03309	(5.37)	0.0000	0.01725	(4.95)	0.0000	0.00333	(0.8)	0.4238	0.00261	(0.63)	0.5288
TX	0.01107			0.00197			0.01069			0.01083		
F value					111.032	0.0000		51.529	0.0000		52.425	0.0000

F-test statistics is used to examine the validity of the restriction:

$$F = \left[\left(e_r^2 - e_f^2\right)\Big/J\right]\Big/\left[e_f^2/(T-K)\right] = (\lambda^{-2/T} - 1)(T-K)/J,$$

where e_f and e_r are error terms of the full and restricted models, T, J, and K are number of data, restrictions, and parameters, respectively.

TABLE 6: Estimation Results of AIDS (3)

(1)

α	Estimate	T Ratio	P Value	Estimate	T Ratio	P Value
FD	0.64382	(28.19)	<0.0001	0.01745	(15.86)	<0.0001
LS	0.12536	(5.87)	<0.0001	0.00014	(0.14)	0.8917
EG	0.20832	(33.8)	<0.0001	0.00530	(18.48)	<0.0001
FN	0.07481	(7.65)	<0.0001	0.00046	(0.98)	0.3271
MD	0.08730	(10.32)	<0.0001	−0.00278	(−6.97)	<0.0001
TS	0.06060	(2.19)	0.029	0.00233	(1.72)	0.0856
CM	0.12514	(21.58)	<0.0001	−0.00137	(−4.99)	<0.0001
ED	−0.00126	(−0.07)	0.9475	0.01292	(13.89)	<0.0001
OT	−0.31470	(−7.63)	<0.0001	−0.02717	(−13.7)	<0.0001
HS	−0.00316	(−0.09)	0.93	−0.00529	(−3.3)	0.001
TX	−0.00622			−0.00199		

α	Under 29 Estimate	T Ratio	P Value	30s Estimate	T Ratio	P Value	40s Estimate	T Ratio	P Value	50s Estimate	T Ratio	P Value	Over 60 Estimate	T Ratio	P Value
FD	0.09735	(1.26)	0.2088	−0.13444	(−2.89)	0.0039	0.20836	(5.18)	<0.0001	−0.05039	(−1.21)	0.228	0.06184	(1.71)	0.087
LS	−0.07072	(−1)	0.3177	−0.11637	(−2.74)	0.0062	0.43242	(11.77)	<0.0001	−0.04777	(−1.25)	0.2108	−0.14833	(−4.48)	<0.0001
EG	0.07241	(3.64)	0.0003	0.01720	(1.44)	0.1498	−0.00962	(−0.93)	0.3521	0.00660	(0.61)	0.539	0.02921	(3.13)	0.0018
FN	−0.04299	(−1.32)	0.1853	−0.00537	(−0.28)	0.7829	0.02262	(1.34)	0.1797	0.00570	(0.33)	0.7446	−0.02454	(−1.62)	0.1056
MD	0.00073	(0.03)	0.9787	0.04839	(2.95)	0.0032	0.02898	(2.04)	0.0414	0.00207	(0.14)	0.888	0.01040	(0.81)	0.4163
TS	−0.78588	(−8.23)	<0.0001	0.07090	(1.24)	0.2164	−0.07392	(−1.49)	0.1361	−0.12531	(−2.43)	0.0151	−0.22089	(−4.97)	<0.0001
CM	0.00993	(0.53)	0.5987	0.01927	(1.7)	0.0887	−0.03810	(−3.89)	0.0001	−0.01257	(−1.24)	0.2164	−0.01686	(−1.91)	0.0561
ED	0.03707	(0.56)	0.5778	−0.00742	(−0.19)	0.8528	−0.33095	(−9.58)	<0.0001	−0.23791	(−6.62)	<0.0001	0.10467	(3.38)	0.0007
OT	0.26367	(1.84)	0.0652	0.34712	(4.04)	<0.0001	−0.45567	(−6.15)	<0.0001	−0.00593	(−0.08)	0.9388	−0.29406	(−4.42)	<0.0001
HS	0.39851	(3.05)	0.0023	−0.23267	(−2.96)	0.0031	0.15793	(2.34)	0.0193	0.45355	(6.43)	<0.0001	0.56588	(9.31)	<0.0001
TX	0.01992			−0.00660			0.05795			0.01196			−0.06731		

(2)

β	Estimate	T Ratio	P Value	Under 29 Estimate	T Ratio	P Value	30s Estimate	T Ratio	P Value	40s Estimate	T Ratio	P Value	50s Estimate	T Ratio	P Value	Over 60 Estimate	T Ratio	P Value
FD	−0.08761	(−21.89)	<0.0001	−0.02380	(−1.71)	0.0882	0.02234	(2.77)	0.0056	−0.03352	(−4.99)	<0.0001	0.00768	(1.11)	0.267	−0.00939	(−1.53)	0.1271
LS	−0.00150	(−0.4)	0.6885	0.01603	(1.26)	0.2087	0.02491	(3.38)	0.0007	−0.07157	(−11.66)	<0.0001	0.00464	(0.73)	0.463	0.02436	(4.33)	<0.0001
EG	−0.02983	(−27.58)	<0.0001	−0.01391	(−3.88)	0.0001	−0.00355	(−1.72)	0.0864	0.00151	(0.87)	0.3824	−0.00087	(−0.49)	0.6229	−0.00435	(−2.74)	0.0062
FN	−0.00761	(−4.43)	<0.0001	0.00777	(1.33)	0.184	0.00088	(0.26)	0.7951	−0.00419	(−1.49)	0.1368	−0.00073	(−0.25)	0.8011	0.00454	(1.76)	0.079
MD	−0.00863	(−5.81)	<0.0001	0.00076	(0.15)	0.8778	−0.00788	(−2.77)	0.0056	−0.00520	(−2.19)	0.0284	−0.00087	(−0.36)	0.7218	−0.00096	(−0.44)	0.66
TS	0.00034	(0.07)	0.944	0.14970	(8.7)	<0.0001	−0.01037	(−1.04)	0.2973	0.01177	(1.42)	0.1552	0.02041	(2.39)	0.0168	0.03549	(4.69)	<0.0001
CM	−0.01652	(−16.21)	<0.0001	−0.00201	(−0.59)	0.5539	−0.00368	(−1.87)	0.0609	0.00651	(3.98)	<0.0001	0.00246	(1.46)	0.1447	0.00257	(1.71)	0.087
ED	0.00037	(0.11)	0.9127	−0.01031	(−0.86)	0.3906	0.00012	(0.02)	0.9864	0.05875	(10.18)	<0.0001	0.03863	(6.49)	<0.0001	−0.02174	(−4.12)	<0.0001
OT	0.10683	(14.83)	<0.0001	−0.04957	(−1.92)	0.0545	−0.06380	(−4.28)	<0.0001	0.07349	(5.93)	<0.0001	0.00632	(0.49)	0.6209	0.04665	(4.12)	<.0001
HS	0.03309	(5.37)	<0.0001	−0.07241	(−3.07)	0.0021	0.03903	(2.86)	0.0043	−0.02795	(−2.48)	0.0132	−0.07547	(−6.46)	<0.0001	−0.08757	(−8.47)	<.0001
TX	0.01107			−0.00225			0.00200			−0.00961			−0.00219			0.01040		

TABLE 6: Continued

(3)

	γ 1			γ 2			γ 3			γ 4			γ 5			γ 6		
	Estimate	T Ratio	P Value	Estimate	T Ratio	P Value	Estimate	T Ratio	P Value	Estimate	T Ratio	P Value	Estimate	T Ratio	P Value	Estimate	T Ratio	P Value
FD	−0.00966	(−1.15)	0.2503	−0.04222			0.02717			0.01976			−0.00259			0.05280		
LS	−0.04222	(−6.85)	<0.0001	0.00865	(1)	0.3194	0.00365			−0.00915			0.00697			−0.02152		
EG	0.02717	(13.46)	<0.0001	0.00365	(1.87)	0.0621	0.02912	(32.32)	<0.0001	−0.01453			−0.00344			−0.02859		
FN	0.01976	(6.57)	<0.0001	−0.00915	(−2.97)	0.003	−0.01453	(−14.46)	<0.0001	0.01738	(7.82)	<0.0001	−0.01183			0.02323		
MD	−0.00259	(−0.87)	0.3867	0.00697	(2.27)	0.0234	−0.00344	(−3.34)	0.0008	−0.01183	(−7.25)	<0.0001	0.03163	(13.52)	<0.0001	−0.01813		
TS	0.05280	(9.19)	<0.0001	−0.02152	(−3.84)	0.0001	−0.02859	(−16.97)	<0.0001	0.02323	(8.52)	<0.0001	−0.01813	(−7.31)	<0.0001	−0.03755	(−4.91)	<0.0001
CM	0.01344	(6.66)	<0.0001	−0.01421	(−6.83)	<0.0001	−0.00429	(−6.23)	<0.0001	−0.01053	(−9.03)	<0.0001	0.00937	(8.3)	<0.0001	−0.03038	(−17.95)	<0.0001
ED	0.02098	(7.34)	<0.0001	−0.00514	(−1.83)	0.067	0.01164	(14.07)	<0.0001	−0.01662	(−12.83)	<0.0001	0.00283	(2.31)	0.0208	−0.03732	(−12.25)	<0.0001
OT	−0.05412	(−6.35)	<0.0001	0.05124	(5.73)	<0.0001	−0.01475	(−5.99)	<0.0001	−0.00171	(−0.44)	0.6634	−0.00379	(−0.95)	0.3431	0.06777	(8.16)	<0.0001
HS	0.00281	(1.27)	0.2028	0.03516	(16.37)	<0.0001	−0.00490	(−8.09)	<0.0001	−0.00486	(−5.01)	<.0001	−0.00206	(−2.27)	0.0232	−0.00992	(−3.94)	<0.0001
TX	−0.02837			−0.01342			−0.00107			0.00886			−0.00896			0.03961		

	γ 7			γ 8			γ 9			γ 10			γ A		
	Estimate	T Ratio	P Value	Estimate	T Ratio	P Value	Estimate	T Ratio	P Value	Estimate	T Ratio	P Value	Estimate	T Ratio	P Value
FD	0.01344			0.02098			−0.05412			0.00281			−0.02837		
LS	−0.01421			−0.00514			0.05124			0.03516			−0.01342		
EG	−0.00429			0.01164			−0.01475			−0.00490			−0.00107		
FN	−0.01053			−0.01662			−0.00171			−0.00486			0.00886		
MD	0.00937			0.00283			−0.00379			−0.00206			−0.00896		
TS	−0.03038			−0.03732			0.06777			−0.00992			0.03961		
CM	0.01273	(11.77)	<0.0001	0.00277			0.01237			−0.00437			0.01310		
ED	0.00277	(3.36)	0.0008	0.03437	(14.76)	<0.0001	−0.02871			0.02660			−0.01140		
OT	0.01237	(5.06)	<0.0001	−0.02871	(−6.35)	<0.0001	0.07516	(4.39)	<0.0001	−0.09571			−0.00775		
HS	−0.00437	(−7.21)	<0.0001	0.02660	(15.62)	<0.0001	−0.09571	(−25.23)	<0.0001	0.04853	(14.39)	<0.0001	0.00872		
TX	0.01310			−0.01140			−0.00775			0.00872			0.00068		

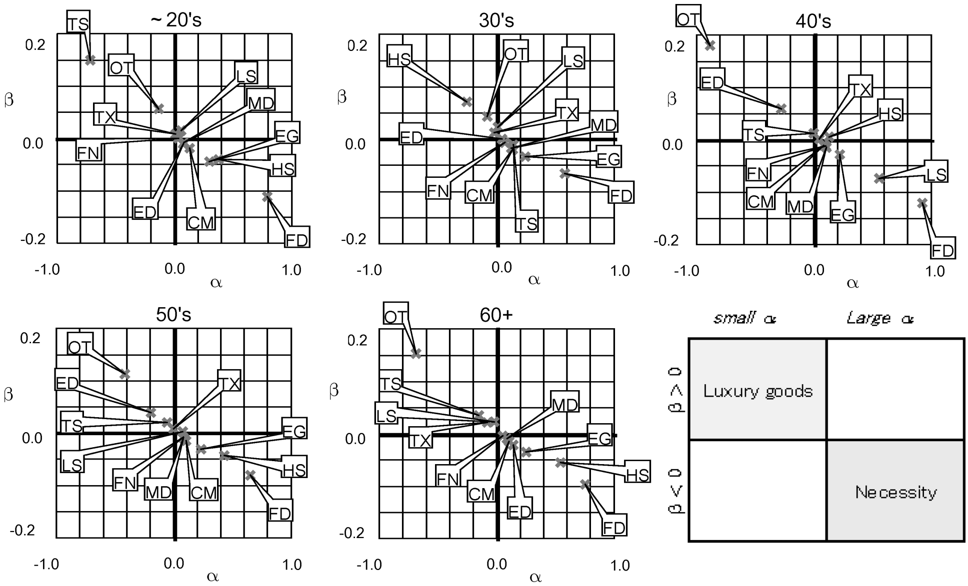


FIGURE 3: Life-Cycle Shifts of Parameters (1).

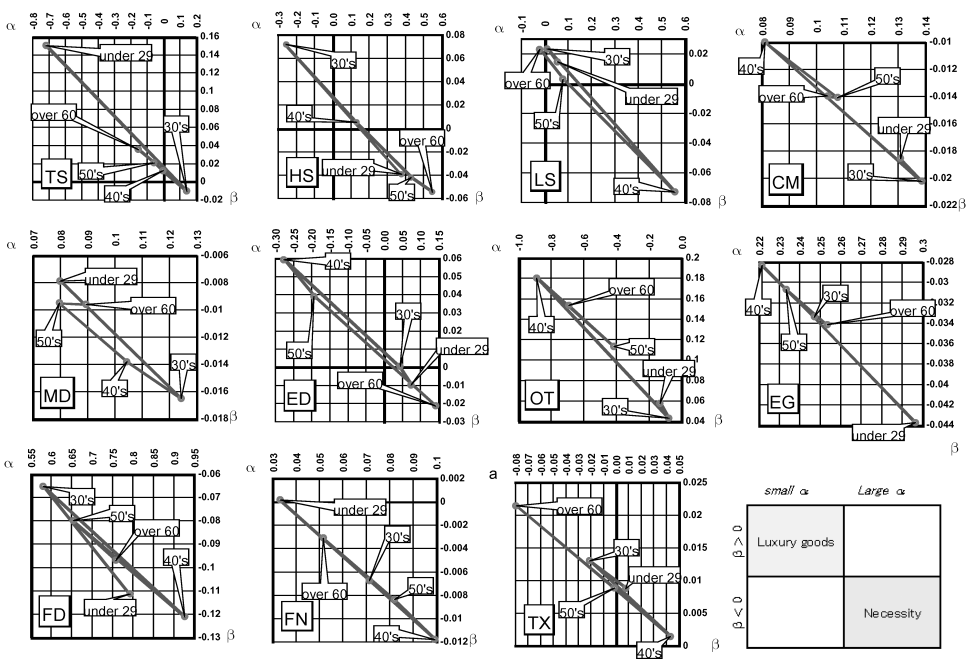


FIGURE 4: Life-Cycle Shifts of Parameters (2).

How do these categorizations vary across the life cycle? By examining Figure 3, one can observe shifts in household preferences across the life cycle. For example, transportation (TS) locates in the upper box in the age group U29. Since transportation expenditure includes expenditures on cars, one could surmise that the younger household's income elasticity for cars is high, because in general they do not need to spend money on any other expensive goods and services when their budget allows them to spend more.

Figure 4 illustrates the same parameter shifts, but from another dimension. The scales of axes are different among each category. It is worth a reminder that the scales of dependent variables are not the same in different goods and services; therefore, they are not comparable by scale among different categories. Even a relatively slight shift of parameters may mean significant differences in some goods, whose budget shares are relatively small.

Looking at transportation (TS), the parameter set of U29 is located in the upper left of the box; it moves downward considerably into the corner of lower right and β becomes negative when a household moves into its life stage of the 30s. In other life periods, 40s, 50s, and 60+, β is positive and it means that the income elasticity is greater than one in these periods. However, it is not so high as in the age group of U29. However, it should be noted that these data refer to shares of income and, clearly, income could normally be expected to increase with age. Thus, the total volumes of expenditure on transportation may be higher in later years even though the share values may never reach the values observed for U29. It is also likely that the type of automobile purchased will also be different. These implications may turn out to be very important information for the supplying industry, especially in the light of the aging of the Japanese population.

On the other hand, looking at expenditures on housing (HS) β is the highest in 30s and one can observe negative coefficients in U29, 50s, and 60+. In Japan, it is common to buy a house after one enters the 30s since access to mortgage instruments increases according to the household heads' employment tenure. It is reasonable to assume that with larger budgets, these households can afford to pay more for housing. Therefore, income elasticity in housing expenditure is high in the 30s.

In general, leisure is considered as luxury, so that income elasticity of leisure would be expected to be above one.[2] However, according to the estimation result, the β coefficient of 40s is negative and this means income elasticity is less than one. It happens as a counterpart effect of higher income elasticity in education and miscellaneous expenses in this life stage.

From the section, it was noted that younger households spend more on communication. However, their consumption behavior does not reflect higher income elasticities. In fact, their income elasticity is lower than others. Their

[2] As one referee noted, the price of leisure is difficult to estimate; for older households, non wage and salary income assumes a greater role in consumption decisions further complicating the issue.

expenditures on communication may be considered in large part as though it were a fixed cost in their budget so that the level of income does not affect their behavior.

The income elasticity of medical care expenditure is higher in U29 and over 50s. A change from the 50s to 60+ years is notable, with a shift into the right without losing the height. This shift can be interpreted to mean that income elasticity increases without losing importance of the basic expenditure on medical care when households move into their life stage of 60+ years. This finding is not unreasonable when the health demands of the elderly are considered.

The β coefficient of education is higher in 40's and 50's. In these life stages, most of households have children enrolled in higher education. As noted earlier, many parents opt to send their children to private schools—both high school and tertiary levels, creating significant demands on their income.

Energy consumption is a necessity so that the β coefficient never becomes positive. However, there is a slight shift across different life stages. Basically, the younger households have smaller income elasticities than older households. However, when a household moves into its life stage of more than 60+ years, the elasticity decreases while α increases, the interpretation being that basic expenditure on energy is relatively much larger in this age group.

Two final tests were conducted: the first explores temporal variations in α and β, and the second examined regional variations. Table 7 presents the results of the tests for temporal variations in α and β. Here, time dummies in the parameters of one of the age dummies is introduced in order to allow these parameters to vary over time. Now, the parameters for α and β are defined as follows in a modification of equation (13):

$$\alpha_i = \alpha_{i0} + e_i n + \sum_{k \neq age_q} \alpha_{ik} Dage_k + \Big(\alpha_{iage_q} + \sum_t \alpha_{it} Dyear_t\Big) Dage_{age_q}$$

$$\beta_i = \beta_{i0} + \sum_{k \neq age_q} \beta_{ik} Dage_k + \Big(\beta_{iage_q} + \sum_t \beta_{it} Dyear_t\Big) Dage_{age_q}$$

where t varies for each year of 1984, 1989, and 1994, respectively (the year of 1999 is set as a benchmark). F statistics test whether the effects of temporal variations are significant or not, and in each age group they confirm that they are very significant. The implication here is that variation by similar cohorts

TABLE 7: Tests for Temporal Variations in α and β

	With Effect on α, β		With Effect on β		With Effect on α	
	F Stat.	*P* Value	*F* Stat.	*P* Value	*F* Stat.	*P* Value
Under 29	21.1953	0.0000	39.4114	0.0000	38.8023	0.0000
30s	21.1953	0.0000	39.4114	0.0000	38.8023	0.0000
40s	21.1953	0.0000	39.4114	0.0000	38.8023	0.0000
50s	21.1953	0.0000	39.4114	0.0000	38.8023	0.0000
Over 60	21.1953	0.0000	39.4114	0.0000	38.8023	0.0000

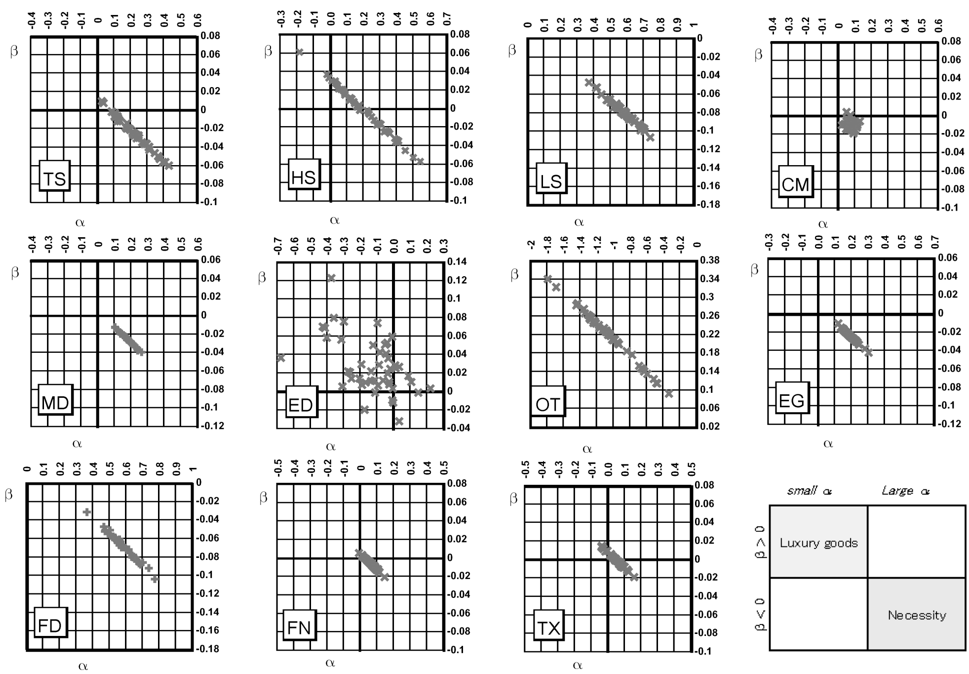


FIGURE 5: Regional Variations in the Parameters α and β Plotted on the Same Scale.

over time is potentially as important as the variation across cohorts at one point in time; clearly, there is the further complication of an age-time interaction that may be attributed to changes in consumer preferences.

Figure 5 and Table 8 present the regional variations in the parameters; the scales in Figure 5 are the same for all goods to facilitate comparison.

TABLE 8: Regional Variations in the Parameters

α	Mean	Std.Dev	Coefficient of Variation	β	Mean	Std.Dev	Coefficient of Variation
ED	−0.125	0.171	−1.364	HS	−0.002	0.025	−10.525
HS	0.205	0.152	0.744	TX	−0.002	0.007	−3.089
TX	0.060	0.043	0.710	ED	0.027	0.029	1.070
TS	0.224	0.099	0.440	FN	−0.008	0.005	−0.682
FN	0.073	0.031	0.425	TS	−0.026	0.017	−0.664
OT	−1.049	0.309	−0.294	CM	−0.010	0.004	−0.398
CM	0.078	0.022	0.289	OT	0.218	0.053	0.246
MD	0.178	0.036	0.202	MD	−0.025	0.006	−0.243
EG	0.196	0.035	0.182	EG	−0.024	0.006	−0.240
LS	0.579	0.079	0.137	FD	−0.068	0.013	−0.191
FD	0.581	0.075	0.129	LS	−0.080	0.012	−0.155

Unfortunately, it was not possible to conduct a detailed cohort-region analysis since there were not enough years of observations; hence, the regional variations reflect the significance of differences in aggregate (across all cohorts) consumption. Regional variations of parameters are relatively large in housing (HS), education (ED), and clothing (TX), and relatively small in food (FD) and leisure (LS). Negative correlations are observed in most goods and commodities except for communication (CM) and education (ED). Regional variation in housing comes from rent. As noted previously in Table 3, there exists huge differences in land values and therefore housing price indices, between urban areas (including suburbs) and rural areas; therefore, one should not be surprised to see this reflected in differences in consumption behavior (in terms of differences in the allocation of income for this commodity).

Regional variations in education expenditures are derived from the availability of school of different types. Children living in urban cities have the opportunity to go to private schools whereas those in rural cities do not have this choice and, thus, most of them go to public schools. Hence, most of the variation in educational expenditure can be attributed to whether the expenditures are for private and public schools—but these distinctions are not reported in the data. Further, parents in the higher-income brackets have a higher propensity to spend on the education of their children and those in urban areas have more opportunity to do, since they have easier access to (more expensive) private services (not only private schools but additional programs to help their children achieve higher academic results). On the other hand, those parents in rural areas do not have this option, and so their income effects do not change as much.

6. CONCLUSION

Several important implications can be drawn from this analysis. First, given the role of consumption expenditures in regional economies, it will become imperative to consider disaggregating household demands by age group. While the demographic components have been linked in many regional econometric input-output models (see Israilevich et al., 1997; Treyz, 1993), consumption is still often entered as an aggregation of household types. In many regional computable general equilibrium models, the demographic-related influences have not been accorded much prominence, with most attention directed to closure rules and functional forms. As these models become more dynamic in character, it will be difficult to justify the noninclusion of greater specification of consumption behavior by cohort.

In the United States, many regional economies are becoming increasingly dependent on nonwage and salary incomes, reflecting in-migration of retirees. Their expenditure patterns need to be considered much more carefully, since assigning them an "average" expenditure profile of all household types will generate incorrect demand signals for some sectors of the economy. At the same time, many regions are experiencing significant in-migration of younger, foreign-born households. Hence, a further dimension to the Japanese case study would need to be considered—age, location, and perhaps ethnic background.

A second important implication from these findings is the potential for variation by cohort over time, reflecting differences in tastes, disposable income, and location preferences. With increasing amounts of consumption now initiated electronically, matching regional income and consumption expenditures by location will become ever more difficult.

The final implication is the need to allocate more effort in model building to the income-consumption links. Li *et al.* (1999) and Rose and Li (1999) have demonstrated that it is possible to build data bases that go a long way in replicating the type of panel data used in this paper. However, to date, only a few studies have taken advantage of these sources of model enrichment. For short-term impact assessment, these omissions may not be serious, but for longer-term forecasting, the results may be severely compromised by neglect of household cohort consumption behavior.

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APPENDIX

TABLE A1: Tests of Significance of the Regional Price Indices.

		Year =1984				Year = 1989				Year = 1994				Year = 1999			
		Mean	Std. Dev.	Variances	Mean	Mean	Std. Dev.	Variances	Mean	Mean	Std. Dev.	Variances	Mean	Mean	Std. Dev.	Variances	Mean
Pfd	Upper half	0.8501	0.0135	Equal	Unequal	0.8713	0.0138	Equal	Unequal	0.9780	0.0140	Equal	Unequal	0.9913	0.0142	Equal	Unequal
	Lower half	0.8910	0.0191			0.9166	0.0190			1.0256	0.0204			1.0391	0.0205		
Pls	Upper half	0.7989	0.0094	Unequal	Unequal	0.8574	0.0132	Unequal	Unequal	0.9558	0.0162	Unequal	Unequal	0.9470	0.0219	Unequal	Unequal
	Lower half	0.8351	0.0196			0.9029	0.0305			1.0111	0.0336			1.0112	0.0379		
Peg	Upper half	1.0914	0.0212	Unequal	Unequal	0.9327	0.0199	Unequal	Unequal	0.9852	0.0184	Unequal	Unequal	1.0026	0.0244	Unequal	Unequal
	Lower half	1.1767	0.0433			1.0251	0.0453			1.0809	0.0429			1.0996	0.0455		
Pfn	Upper half	1.0089	0.0108	Equal	Unequal	1.0090	0.0109	Equal	Unequal	1.0149	0.0203	Equal	Unequal	0.9350	0.0277	Equal	Unequal
	Lower half	1.0506	0.0153			1.0484	0.0161			1.0685	0.0207			1.0279	0.0363		
Pmd	Upper half	0.8431	0.0082	Equal	Unequal	0.9471	0.0097	Equal	Unequal	0.9914	0.0095	Equal	Unequal	1.1106	0.0124	Equal	Unequal
	Lower half	0.8625	0.0074			0.9708	0.0073			1.0143	0.0067			1.1416	0.0090		
Pts	Upper half	0.9416	0.0192	Equal	Unequal	0.9470	0.0147	Equal	Unequal	0.9878	0.0206	Equal	Unequal	0.9295	0.0283	Equal	Unequal
	Lower half	0.9733	0.0139			0.9825	0.0142			1.0322	0.0161			0.9956	0.0313		
Pcm	Upper half	1.0699	0.0054	Unequal	Unequal	1.0435	0.0032	Unequal	Unequal	0.9365	0.0066	Unequal	Unequal	0.9288	0.0112	Unequal	Unequal
	Lower half	1.0911	0.0154			1.0627	0.0127			0.9612	0.0143			0.9639	0.0182		
Ped	Upper half	0.5677	0.0260	Unequal	Unequal	0.6935	0.0308	Unequal	Unequal	0.8596	0.0319	Unequal	Unequal	0.9291	0.0577	Equal	Unequal
	Lower half	0.6560	0.0553			0.8008	0.0636			0.9676	0.0661			1.0813	0.0698		
Pot	Upper half	0.8570	0.0124	Equal	Unequal	0.9113	0.0156	Unequal	Unequal	0.9718	0.0204	Equal	Unequal	1.0020	0.0291	Equal	Unequal
	Lower half	0.8803	0.0091			0.9408	0.0093			1.0159	0.0220			1.0720	0.0366		
Phs	Upper half	0.6573	0.0203	Unequal	Unequal	0.7046	0.0339	Unequal	Unequal	0.7788	0.0348	Unequal	Unequal	0.7599	0.0597	Unequal	Unequal
	Lower half	0.7631	0.0771			0.8358	0.1060			0.9433	0.1447			1.0014	0.1715		
Ptx	Upper half	0.7630	0.0197	Equal	Unequal	0.8534	0.0348	Unequal	Unequal	0.9585	0.0380	Unequal	Unequal	0.9883	0.0487	Unequal	Unequal
	Lower half	0.8121	0.0194			0.9223	0.0222			1.0352	0.0242			1.0974	0.0316		

Test at 5% significance level.