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Abstract

A transition from the demand for goods to that for services has occurred in Japanese households since the late 1990s. In this context, this study examines the weak separability of preference between goods and services using age group panel data. We first conduct a parametric test of weak separability using the quadratic almost ideal demand system model of Banks, Blundell, and Lewbel (1997). As a result, the hypothesis of weak separability of preference between goods and services is not rejected. Next, we use the generalized composite commodity theorem (GCCT) of Lewbel (1996), which does not assume weak separability, to confirm the robustness of the weak separability test results. This test verifies that the relative prices of goods and services are independent with respect to the group index to which each relative price belongs by the panel cointegration test. As a result, we show that the relative prices of goods and services are independent and, at the same time, the test results of weak separability and GCCT are consistent. Furthermore, this indicates that the weak separability between goods and services may contribute to the ongoing shift from goods to services.

Keywords: Weak separability; Linearly approximated quadratic almost ideal demand system model; Generalized composite commodity theorem; Panel cointegration test

JEL codes: D12

1. Introduction

Until the early 1990s, Japanese households spent heavily on owning goods as a symbol of their affluence. According to the Family Income and Expenditure Survey from 1985 to 1993, their expenditure on “tangible goods” accounted for more than 60% of their total expenditure. However, when Japan’s bubble economy collapsed in 1991, household values diversified. As such, since the late 1990s, there has been an increase in the expenditure on “intangible services” by finding value in experiences and memories that cannot be obtained by owning goods. This is commonly referred to as “koto shouhi” in Japanese. The proportion of expenditure on intangible services gradually started exceeding that on tangible goods and there was a transition from the demand for goods to that for services. The shift from the demand for goods to services relatively occurred early in the younger age groups and later in the older age groups. This trend is particularly pronounced among those aged over 65. We assume that one reason is the weak separability of consumer preferences between goods and services. In other words, Japanese households tend to regard goods and services as separate preference groups and will tend to prefer to consume commodities that belong to the service group. However, separating goods and services that originally belonged to the same major group leads to the strict assumption that services are not substitutable by goods and can only be substituted by other services. This may have contributed to the ongoing shift from goods to services.

Regarding demand systems research, Moschini, Moro, and Green (1994) and Nayga and Capps (1994) are well-known in the literature for advocating tests of weak separability. A previous study using the quadratic almost ideal demand system (QUAIDS) model of Banks, Blundell, and Lewbel (1997) has been applied to U.S. caloric sweetener demand analysis by Lakkakula, Schmitz, and Ripplinger (2016). In Japan, Asano (1997) and Sumimoto and Kusakari (2006) examine the weak separability of food demand and leisure. Asano (1997) reject the null hypothesis of weak separability, but Sumimoto and Kusakari (2006) do not reject it. Additionally, Shigeno (2004) examines the weak separability of food demand and domestic work and rejects the null hypothesis of weak separability. Furthermore, Ogawa and Okamura (2001) and Yokoyama (2010) examine the weak separability of household consumption and leisure and reject the null hypothesis of weak separability. Therefore, in Japan, there are many studies on the weak separability of consumer demand and leisure. However, no previous study refers to the weak separability of goods and services. the GCCT estimation without separability assumption was generalized by Lewbel (1996) and has since been discussed in studies such as Davis, Lin, and Shumway (2000), Reed, Levedahl, and Hallahan (2005), and Schulz, Schroeder, and Xia (2012). For example, Reed et al. (2005) applied it to estimating food demand and simplified the existing tests of the GCCT by Lewbel (1996). In addition, about the transition from goods to services, there is a variety of literature in the field of business marketing, such as Vargo and Lusch (2008) and Wolfson, Dominguez-Ramos, and Irabien (2019), but there is little literature in the field of economics.

The purpose of this study is examining the weak separability between goods and services, which contributed to the transition from the demand for goods to that for services in Japan since the late 1990s. Additionally, the study examines whether robustness can be obtained for both results using the generalized composite commodity theorem (GCCT) of Lewbel (1996), which does not assume weak separability. Since the parametric weak separability test depends on the functional form, it is useful to verify whether the test is also valid for the GCCT without using functional forms. Recently, the transition from goods to services has also occurred outside of Japan, the contribution of this study is testing this hypothesis by linking it to the weak separability of consumer preference between goods and services. By examining the weak separability between goods and services, this study also proposes policy implications for improving the current level of consumption expenditures by Japanese households.

The remainder of this paper proceeds as follows. Section 2 presents the data used in the analysis, and Section 3 explains the weakly separable preference in the Japanese Family Income and Expenditure Survey. Section 4 presents the estimation model and Section 5 shows the estimation results, weak separability test, and the GCCT test results. Finally, Section 6 draws the conclusions of this study.

2. Data

The household data employed in this study comprise annual data for all households in six age groups. We sourced data on expenditure for each commodity group and household demographics from the Family Income and Expenditure Survey (*Kakei Chosa* in Japanese) conducted between 1985 and 2020 by the Japanese Statistics Bureau and use six age groups: under 29, 30–39, 40–49, 50–59, 60–64, and over 65.[1] The expenditure data are generally classified into 10 major groups: food; housing; fuel, light, and water charges; furniture and household utensils; clothing and footwear; medical care; transportation and communication; education; culture and recreation; and other consumption expenditures. We further divided these groups into goods and services according to the objectives of this study.[2] The survey is then progressively subdivided into major categories, medium categories, small categories, and item categories, but it is necessary to go back to the item categories to accurately separate goods and services. Following that, the survey is reaggregated to the medium categories and reorganized into the goods and services of each major category. These classifications followed the Income and Expenditure Item Classification Table published by the Japanese Statistics Bureau.[3] Consequently, we obtain a total of 19 groups consisting of goods and services. Of course, it is necessary to verify whether goods and services are separable within each major category in this classification. In addition, the demographic data indicate the number of household members and age of the household head. We also obtain price data from the consumer price index, with 2020 as the base year.

Table 1 shows the descriptive statistics of the budget shares of the 19 sub-groups consisting of goods and services. The highest share of goods is held by food and culture and recreation, while the highest share of services is found in housing and transportation and communication. Among these, the highest share is for food goods. The difference between the maximum and minimum values for food goods is large because of the large difference in budget shares by age. However, transportation and communication services, which has the next highest share, does not have a large difference between

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[1] For the 60s group, the data were divided into those aged 60–64 and those over 65 due to data limitations. In Japan, those aged over 65 are classified as elderly.

[2] Unlike the other commodity group, all fuel, light, and water charges are classified as goods.

[3] However, the household data used in this analysis include several cases where goods and services are mixed in one item. Therefore, we subdivided goods and services based on more detailed item classification data and created weights for each item. In sum, all items were accurately classified into goods and services.

the maximum and minimum values, as the difference in budget share by age is relatively small. This indicates that Internet communication is widespread among a wide range of age groups. Some groups are more likely to differ more compared to others, depending on their characteristics. Additionally, for many groups, services have larger standard deviations than goods, meaning that the budget share for services has been growing year by year.

Figures 1(a) and (b) show the total budget shares for goods and services in the age groups up to 49 and over 50. In Figure1(a), for the relatively younger age groups, the budget share for services exceeded that of goods in 2001. Since 1985, the budget share for goods has been declining, while the budget share for services has been increasing. The budget share for services has been on a sharp upward trend until the 2010s. This is because Japanese households have satisfied their demand for goods and shifted to demand services. In 2020, the spread of COVID-19 caused a sharp increase in the budget share for goods in all age groups, but this is likely a temporary uptick. In Figure 1(b), the shift from the demand for goods to that for services is shown to occur later than for the younger age groups, for example, in 2002, for those in their 50s, and in 2006 for those over 65. In other words, the younger an age group is, the faster is the transition from goods to services. Moreover, the difference between the share of goods and services is smaller for the older age groups than for the younger ones, even after the shift to services. In particular, for the age group over 65, the budget share for goods would exceed that for services in 2020 due to the spread of COVID-19 infection. Therefore, the timing of the shift from demand for goods to that for services can be observed for different age groups.

Table 1. Descriptive statistics of budget shares for goods and services in 19 sub-groups

Major groups	No.	Goods or service	Average	Std.Dev	Max	Min
food	1	goods	0.2025	0.0352	0.3113	0.1328
	2	service	0.0411	0.0108	0.0672	0.0186
housing	3	goods	0.0077	0.0048	0.0231	0.0018
	4	service	0.0755	0.0413	0.1888	0.0275
fuel, light, and water charges	5	goods	0.0702	0.0149	0.1156	0.0445
furniture and household utensils	6	goods	0.0589	0.0211	0.1059	0.0315
	7	service	0.0033	0.0009	0.0057	0.0017
clothing and footwear	8	goods	0.0514	0.0105	0.0821	0.0252
	9	service	0.0041	0.0014	0.0076	0.0014
medical care	10	goods	0.0205	0.0047	0.0352	0.0117
	11	service	0.0197	0.0090	0.0466	0.0071
transportation and communication	12	goods	0.0304	0.0199	0.1138	0.0030
	13	service	0.1202	0.0237	0.1686	0.0834
education	14	goods	0.0011	0.0008	0.0028	0.0000
	15	service	0.0410	0.0364	0.1310	0.0020
culture and recreation	16	goods	0.1200	0.0678	0.2719	0.0270
	17	service	0.0576	0.0109	0.0783	0.0277
other expenditure [a]	18	goods	0.0249	0.0032	0.0433	0.0195
	19	service	0.0500	0.0201	0.1057	0.0144

Note: [a] Other expenditure usually has the highest budget share, but since personal expenses, entertainment expenses, and money sent home are not statistically classified as either goods or services, we used the expenditure amount excluding them.

Figure 1(a). The budget shares for goods and services in under 29, 30-39, and 40-49

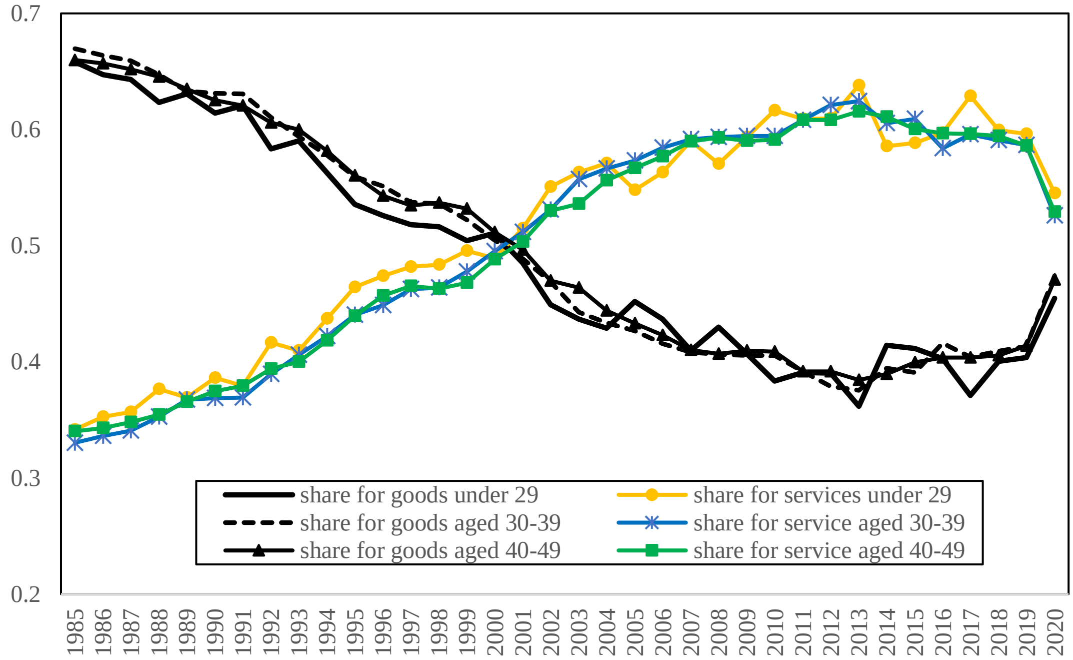
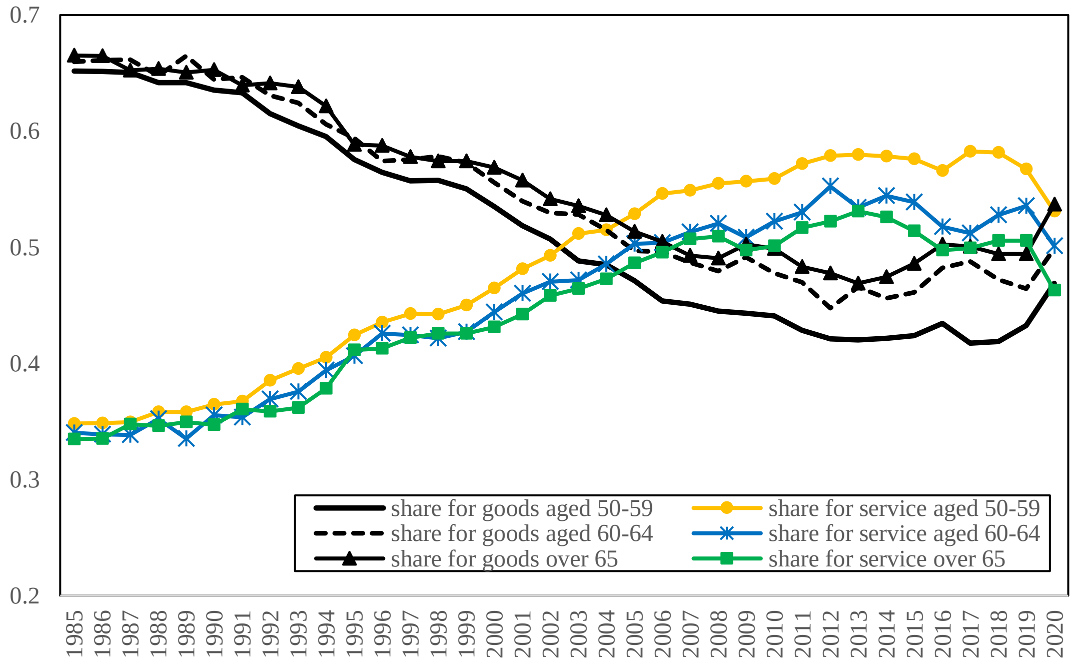


Figure 1(b). The budget shares for goods and services in 50-59, 60-64, and over 65



3. Weak separability of consumer preference between goods and services

In demand systems, the separability assumption is extremely useful for economic modeling because it leads to the specification of two-stage demand systems by aggregating commodities. It is well known that weak separability is a strong assumption but, without it, there would be multicollinearity problems when estimating the demand function due to the large number of explanatory variables in price and the lack of degrees of freedom. In addition, since weak separability is a necessary and sufficient condition for two-stage budgeting to exist, this assumption plays an important role in empirical analyses. In this study, to test the weak separability of preference between goods and services, we perform parametric tests conditional on the functional form of arbitrary separable structures based on utility functions. We first consider a direct utility function consisting of M goods and services, defined as:

$$U(\mathbf{q}) = U^0(q^1, q^2, \cdots, q^M), \tag{1}$$
$$s.t.\ \mathbf{pq} = x$$

where $\mathbf{q} = (q^1, q^2, \dots, q^M)$ denotes a vector of quantity, $\mathbf{p} = (p_1, p_2, \dots, p_M)$ the corresponding price vector, and x total expenditure. We assume utility trees of several patterns to test the weak separability of preference between goods and services. Next, we divide consumer's total expenditure into N sub-groups, such as food goods, food services, housing goods, housing services, and determine their allocation. For example, if utility function $U(\mathbf{q})$ is symmetrically weakly separable in the partition N sub-groups, it can be written as:

$$U(\mathbf{q}) = U^0[U^1(\mathbf{q}^1), U^2(\mathbf{q}^2), \dots, U^N(\mathbf{q}^N)], \tag{2}$$

where U^0 is a monotonic increasing function and $U^N(\cdot)$ is a sub-utility function that depends on a subset $\boldsymbol{q}^N$ of goods and services. This means that this sub-utility function depends only on the expenditure on each sub-group and the prices belonging to it and not depend on any other sub-group. The separable structure in (2) constrains the substitutability in different sub-groups. Additionally, although this separability is restrictive, it is useful for rationalizing the actual estimation.

However, when the sub-groups are divided into two, one for goods and one for services, the expenditures of the two groups are determined based on these expenditures and prices. In this case, utility function $U(\mathbf{q})$ is weakly separable in the partition of two sub-vector groups of goods and services if it can be written as:

$$U(\mathbf{q}) = U^0[U^g(\mathbf{q}^g), U^s(\mathbf{q}^s)], \tag{3}$$

where we denote the vector of goods as $\mathbf{q}^g$ and the vector of services as $\mathbf{q}^s$. Sub-utility functions $U^g(\cdot)$ and $U^s(\cdot)$ depend on sub-group $\mathbf{q}^g$ or $\mathbf{q}^s$. The separable structure of (3) means that it is substitutable only between goods or only between services.

Furthermore, we consider the case where goods and services statistically belonging to the same major category are divided into the same sub-groups, and each group determines its expenditures based on these expenditures and prices. In this case, utility function $U(\mathbf{q})$ is weakly separable in the partition sub-vector groups of goods and services if it can be written as:

$$U(\mathbf{q}) = U^0[U^1(\mathbf{q}^{g,1}, \mathbf{q}^{s,1}), U^2(\mathbf{q}^{g,2}, \mathbf{q}^{s,2}), \cdots, U^m(\mathbf{q}^{g,m}, \mathbf{q}^{s,m})], \tag{4}$$

where $U^m(\cdot)$ is the m-th sub-utility function that depends on subset $\mathbf{q}^{g,m}$ or $\mathbf{q}^{s,m}$ of the m-th groups in goods and services. In (3), the strong constraint that substitution is possible only within the same sub-group is applied. Even in (4), a strong constraint is imposed in that they are substitutable only among goods and services within the same sub-group.

4. The model

Before defining the estimation model, we represent part of the relationship between each budget share and total expenditure using Engel curves. Figures 2(a)–(c) show the Engel curves for the budget share for food and recreation goods and for transportation and communication services. The shapes of the Engel curves show that there are many groups for which the relationship between budget shares and logarithm total expenditures is non-linear. For example, in Figure 2(a), the share of food goods tends to decrease as total expenditure (income) increases to a certain income level; conversely, the share increases when income exceeds this level, and the curve has a gentle U-shape. The recreation goods in Figure 2(c) also shows a similar trend. However, the opposite shape is shown in Figure 2(b) for transportation and communication services. The middle-income group has the highest share, while the low- and high-income groups have the lowest shares. In other words, a quadratic function of the relationship between budget share and total expenditure, such as the QUAIDS model proposed by Banks, Blundell, and Lewbel (1997), is more suitable as an estimation model than when the relationship between budget share and total expenditure is expressed as a linear function, such as the almost ideal demand system (AIDS) model of Deaton and Muellbauer (1980).

The QUAIDS model, similar to the AIDS model, has the characteristics of strictly nonlinear aggregation across consumers and second-order flexibility. In addition, because of its quadratic effect on logarithm total expenditure, the QUAIDS model allows the situation where increased total expenditure turns luxuries into necessities (Matsuda, 2006). For example, it also allows for the case where the budget share decreases in the higher total expenditure group, as in Figure 2(b) for transportation and communication services. Furthermore, the linearly approximated QUAIDS (LAQUAIDS) model of Yohannes and Matsuda (2015) is used in this study. Nonlinear estimation under the QUAIDS model is also practical enough due to the computationally efficient estimation procedure proposed by Blundell and Robin (1999). However, the LAQUAIDS model is more useful when data are limited, the degrees of freedom are never large, and nonlinear restrictions for parameters such as weak separability are used, as in this study.

Figure 2(a) Engel curve in the share of food goods

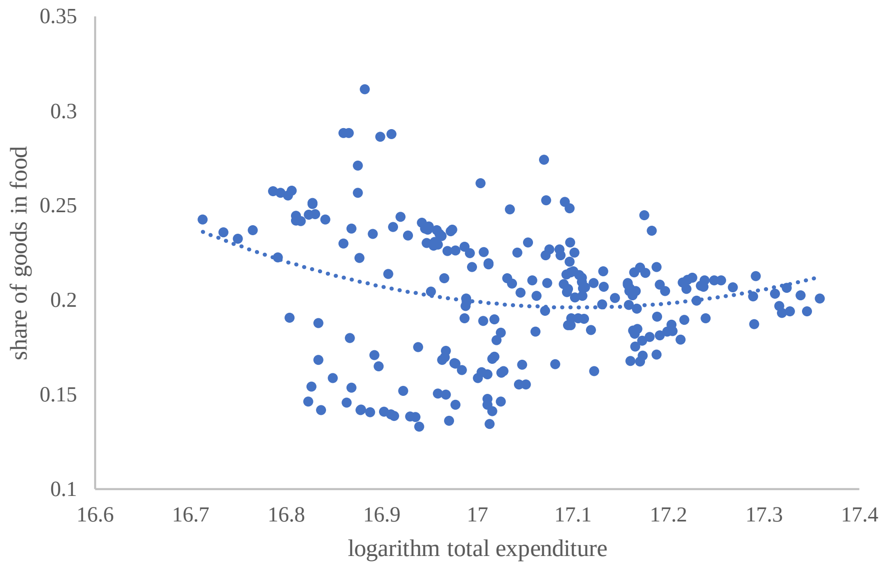


Figure 2(b) Engel curve in the share of transportation and communication services

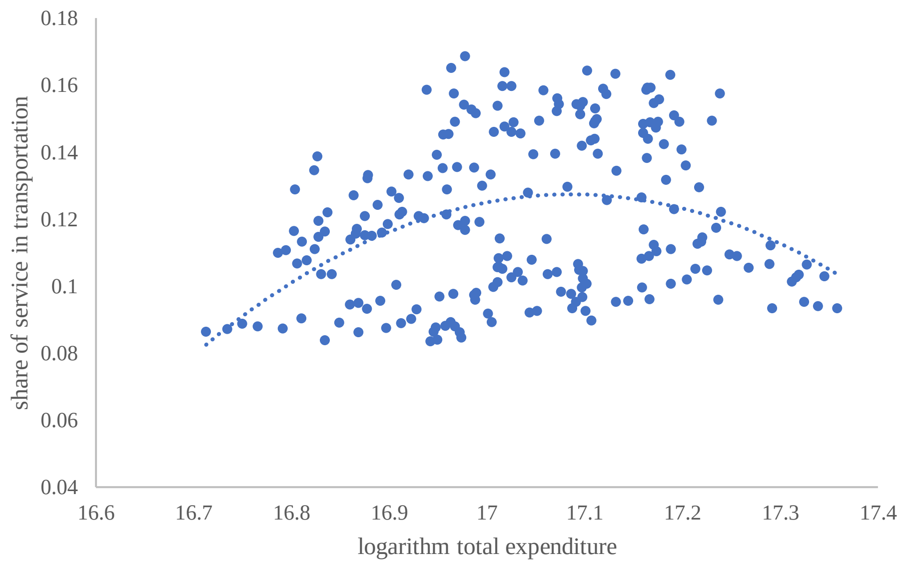
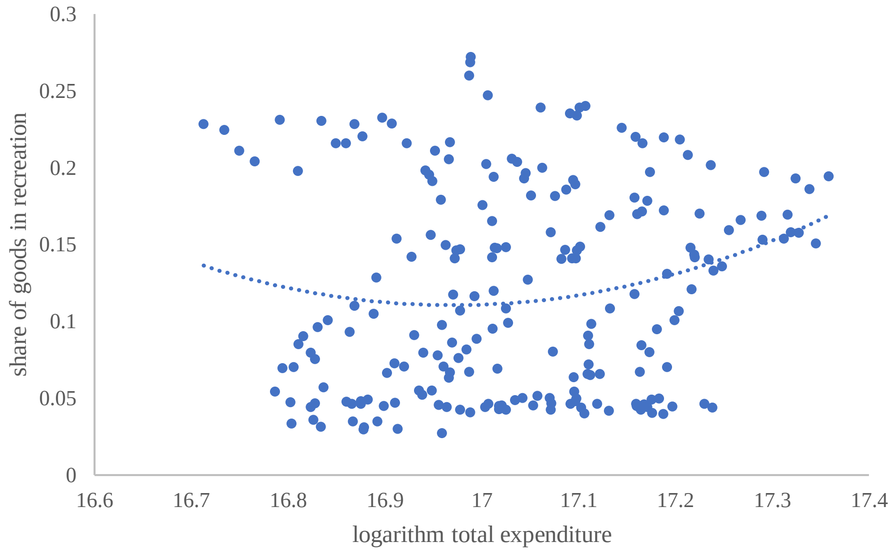


Figure 2(c) Engel curve in the share of recreation goods



The indirect utility function of the original QUAIDS model is specified as

$$\ln V = \left\{ \left[\frac{\ln x - \ln P}{b(\mathbf{p})} \right]^{-1} + \lambda(\mathbf{p}) \right\}^{-1}. \tag{5}$$

where $\ln P$, $b(\mathbf{p})$, and $\lambda(\mathbf{p})$ are price aggregator function.

By applying the Roy's identity to (5), the original QUAIDS model is derived as

$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln p_j + \beta_i \ln \left(\frac{x}{P} \right) + \frac{\lambda_i}{b(\mathbf{p})} \left[\ln \left(\frac{x}{P} \right) \right]^2, \tag{6}$$

where α_i, γ_{ij}, β_i, and λ_i are parameters. And $\ln p_j$ is the logarithm price of sub-group j, $\ln x$ is the logarithm total expenditure. The translog aggregate price index is written as

$$\ln P = \alpha_0 + \sum_{i=1}^{n} \alpha_i \ln p_i + \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \gamma_{ij} \ln p_i \ln p_j. \tag{7}$$

The Cobb–Douglas price aggregator is written as

$$b(\mathbf{p}) = \prod_{i=1}^{n} p_i^{\beta_i}. \tag{8}$$

Linear approximation to the QUAIDS model requires to replace the nonlinear (7) and (8) to linear price aggregator. First, Matsuda (2006) used the Stone price index in the AIDS model suggested by Deaton and Muellbauer (1980) instead of (7). That is,

$$\ln P^S = \sum_{i=1}^{n} \overline{w}_i \ln p_j, \tag{9}$$

where $\overline{w}_i$ denotes the sample mean of w_i, and (9) is invariant to change in units. In addition, Matsuda (2006) proposed the following price aggregator for the approximation to (8).

$$\ln P^{z} = \sum_{i=1}^{n}(w_i - \bar{w}_i)\ln\left(\frac{p_i}{\bar{p}_i}\right), \tag{10}$$

where $\bar{p}_i$ denotes the sample mean of p_i, and (10) is also invariant to change in units.[4] Replacing these in (6), the LAQUAIDS model for individual *k* in period *t* is expressed as

$$w_{it}^{k} = \alpha_i + \sum_{j=1}^{n}\gamma_{ij}\ln p_{jt}^{k} + \beta_i \ln\left(\frac{x}{P^S}\right)_t^k + \frac{\lambda_i}{P^z}\left[\ln\left(\frac{x}{P^S}\right)_t^k\right]^2 + u_{it}^{k}, \tag{11}$$

$$i = 1,2,\dots,n,\ k = 1,\dots,K,\ t = 1,\dots,T,$$

where α_i, γ_{ij}, β_i, and λ_i are parameters. These are imposed on restrictions of demand theory in the estimation. The adding-up is $\sum_{i=1}^{n}\alpha_i = 1, \sum_{i=1}^{n}\beta_i = 0$, and is automatically satisfied by estimating $n-1$ equations. Homogeneity is $\sum_{j=1}^{n}\gamma_{ij} = 0, \sum_{i=1}^{n}\lambda_i = 0$ and Slutsky symmetry is $\gamma_{ij} = \gamma_{ji}$. the error term u_{it}^{k} in (11) can be written as:

$$u_{it}^{k} = \mu^{k} + \theta_{it} + \mathrm{v}_{it}^{k}, \tag{12}$$

where μ^k denotes the individual fixed effect in individual k and θ_{it} denotes a time fixed effect. In addition, v_{it}^{k} is usually assumed to be strictly exogenous, with $E(\boldsymbol{v} \mid \boldsymbol{\mu}, \ln\mathbf{p}, \ln(\mathbf{x}/\mathbf{P^S}), 1/\mathbf{P^Z}\,[\ln(\mathbf{x}/\mathbf{P^S})]^2) = 0$. The panel model of (11) can be estimated by the three stage least squares (3SLS) using instrumental variables of lagged explanatory variables $\ln(\mathbf{x}/\mathbf{P^S})$ and $[\ln(\mathbf{x}/\mathbf{P^S})]^2$. In addition, homogeneity and symmetry constraints are imposed on the estimation of parameters.

The expenditure and uncompensated price elasticities (Yohannes and Matsuda, 2015) are given by

$$\epsilon_i = 1 + \frac{\beta_i}{w_i} + \frac{2\lambda_i}{w_i P^z}\ln\left(\frac{x}{P^S}\right), \tag{13}$$

$$\varepsilon_{ij} = -\delta_{ij} + \frac{\gamma_{ij}}{w_i} - \frac{\beta_i \bar{w}_j}{w_i} - \frac{\lambda_i}{w_i P^z}\left[2\bar{w}_j + (w_j - \bar{w}_j)\ln\left(\frac{x}{P^S}\right)\right]\ln\left(\frac{x}{P^S}\right), \tag{14}$$

where δ_{ij} is the Kronecker delta of $\delta_{ij} = 1$ for $i = j$ and $\delta_{ij} = 0$ for $i \neq j$. The compensated price elasticity is expressed by $\varepsilon_{ij}^{c} = \varepsilon_{ij} + \epsilon_i w_j$.

5. Estimation results

5.1 Test of weak separability between goods and services in Japanese households

Nayga and Capps (1994) described that, if separability restrictions are inconsistent with the true preference ordering of the representative consumer, the empirical estimates of structural demand parameters are invalid. Therefore, it is worthy considering the tests of weak separability before presenting the estimates. Here, we test for consistency with representative consumer preferences by testing for the weak separability between goods and services.

A necessary and sufficient condition for weak separability is that in any two groups, the Slutsky

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[4] It is useful for estimation using linear price aggregator when the number of goods is relatively large and the degrees of freedom are limited, as in this study.

substitution terms between sub-groups belonging to different groups are proportional to the expenditure terms in each group. The restrictions of weak separability expressed as

$$\frac{\sigma_{ik}}{\sigma_{jm}} = \frac{\epsilon_i \epsilon_k}{\epsilon_j \epsilon_m}, \tag{15}$$

where σ_{ij} denotes the elasticity of substitution between sub-group i and j, and ϵ_i denotes the expenditure elasticity of (13).

Let the compensated price elasticity denote $\varepsilon_{ij}^c = \varepsilon_{ij} + \epsilon_i w_j$, the elasticity of substitution is expressed as $\sigma_{ij} = \varepsilon_{ij}^c / w_j$. In (15), substituting (13) and (14) and setting at a mean point, say at $\mathbf{p} = x = 1$. At such a point, $\ln P^s = 0$ and $\ln P^z = 0$ of (11), that is,

$$\frac{\gamma_{ik} - \beta_i \bar{w}_k + w_i w_k + \beta_i w_k}{\gamma_{jm} - \beta_j \bar{w}_m + w_j w_m + \beta_j w_m} = \frac{w_m (w_i + \beta_i)(w_k + \beta_k)}{w_k (w_j + \beta_j)(w_m + \beta_m)}.$$

Further, $\bar{w}_i = w_i = \alpha_i$ at mean point. When $k = m$, the separability restrictions for the LAQUAIDS model can be reduced to

$$\frac{\gamma_{ik} + \alpha_i \alpha_k}{\gamma_{jk} + \alpha_j \alpha_k} = \frac{\alpha_i + \beta_i}{\alpha_j + \beta_j}. \tag{16}$$

This expression is the same as the separability restrictions in the LAIDS model by Moschini, Moro, and Green (1994) when $k = m$ and in the QUAIDS model by Lakkakula, Schmitz, and Ripplinger (2016) when $\alpha_0 = 0$.

Nayga and Capps (1994) introduced that the number of weak separability restrictions for any utility tree can be determined by

$$\left(\frac{1}{2}\right)\left[N^2 + N - R^2 + R - \sum_R n_R (n_R + 1)\right], \tag{17}$$

where N is the number of goods and services and R is the number of separable groups, and n_R is the number of goods and services in group R.

We examine which patterns of weak separability of preference Japanese consumers choose. In Separable structure 1 in (3), when we set $N = 19$, the utility function can be written as:

$$U(\mathbf{q}) = U^0[U^g(\mathbf{q}^1, \mathbf{q}^3, \mathbf{q}^5, \mathbf{q}^6, \mathbf{q}^8, \dots, \mathbf{q}^{18}), U^s(\mathbf{q}^2, \mathbf{q}^4, \mathbf{q}^7, \mathbf{q}^9, \dots, \mathbf{q}^{19})], \tag{18}$$

where $U^g(\cdot)$ denotes the sub-utility function in a group according to goods and $U^s(\cdot)$ denotes the sub-utility function in a group according to services. This simply and clearly expresses the weak separability of preference between goods and services. For example, (18) indicates that consumers substitute food goods for clothing goods within the same sub-utility function.

In Separable structure 2 in (4), the utility function can be written as:

$$U(\mathbf{q}) = U^0[U^F(\mathbf{q}^1, \mathbf{q}^2), U^H(\mathbf{q}^3, \mathbf{q}^4), \cdots, U^O(\mathbf{q}^{18}, \mathbf{q}^{19})], \tag{19}$$

where $U^m(\cdot)$ for $m = F, H \dots, O$ denotes the sub-utility function in a group of goods and services. For example, $U^F(\cdot)$ denotes the sub-utility function of goods and services in food. When m is fuel, light, and water charges, only goods are handled. Furthermore, (19) indicates that consumers originally regard goods and services of the same major group as having the same classification. Consumers substitute between goods and services within the same group. Compared to Separable Structure 1, the constraints are somewhat less restrictive here because we have a separable structure closer to a major category. Additionally, this separable structure is also used to confirm the consistency of the aggregate in the 19 sub-group classification in Table 1 of Section 2.

In Separable structure 3, we consider that three groups of food, housing, and fuel goods and the seven groups of the remaining goods are separable for services. In this case, the utility function can be written as:

$$U(\mathbf{q}) = U^0[U^{g,1}(\mathbf{q}^1, \mathbf{q}^3, \mathbf{q}^5), U^{g,2}(\boldsymbol{q}^6, \mathbf{q}^8, \ldots, \mathbf{q}^{18}), U^s(\mathbf{q}^2, \mathbf{q}^4, \ldots, \mathbf{q}^{19})], \tag{20}$$

where $U^{g,1}(\cdot)$ and $U^{g,2}(\cdot)$ denote the sub-utility function in a group according to goods and $U^s(\cdot)$ denotes the sub-utility function in a group according to services. In this case, consumers separate necessary goods such as food, housing, and fuel goods and the remaining goods from services. Specifically, we consider that food, housing, and fuel goods can maintain a high budget share because consumers separate them from the remaining goods and services.

The test of weak separability was performed by the likelihood ratio (LR) test, $LR = 2[L(\widehat{\boldsymbol{\beta}}_U) - L(\widehat{\boldsymbol{\beta}}_R)]$, where $\widehat{\boldsymbol{\beta}}_U$ is the unrestricted estimator vector, $\widehat{\boldsymbol{\beta}}_R$ is the restricted estimator vector, and $L(\cdot)$ denotes the maximum value of the likelihood function. Table 2 summarizes the results of the weak separability tests for Separable structures 1–3. First, in Separable structure 1 in (18), the null hypothesis that the weak separability of preference between goods and services is established is not rejected at the 5% level. This means that representative households regard goods and services as separate groups. In other words, goods are substituted only for goods and services are substituted only for services. This is a possible determinant of the shift from goods to services. Second, in Separable structure 2 in (19), the null hypothesis that weak separability holds for the 10 major categories consisting of goods and services was not rejected at the 5% level. This means, for example, that goods and services related to food belong to the same group and goods and services related to housing belong to the same group as well. Weak separability can then be interpreted as being established between these groups. This is consistent with the classification of the 10 major categories before dividing the sub-groups into goods and services. Furthermore, this result will also indicate the consistency of the aggregate in the 19 sub-groups described in Section 2. Additionally, the test results of Separable structures 1 and 2 are not contrary to each other. Separable structure 2 is originally in line with the statistical classification of the Family Income and Expenditure Survey, which represents goods and services belonging to the same major group as having the same sub-utility. In other words, there is no contradiction in the result that both Separable structures 1 and 2 are adopted. Separable structure 1 is established on the basis of Separable structure 2. Finally, under Separable structure 3 in (20), the null hypothesis that the group of food, housing, and fuel goods and that of the remaining goods are separable for the group of services was not rejected at the 5% level. Food goods have the highest budget share, which level is maintained even when shifting from goods to services. In the case of housing and fuel goods, the budget share is maintained to some extent because these expenditures are necessary to maintain the standard of living. However, in the remaining goods group, the budget share for goods gradually decreases and shifts to services. Therefore, the group of food, housing, and fuel goods would be separated from the remaining goods and services because these goods are essential necessities to sustain life.

Table 2 The weak separability tests for separable structures

Separable structure	Number of restrictions	LR	P-value
1	79	30.356	1.000
2	100	10.710	1.000
3	98	114.098	0.127

5.2 Estimated elasticity

Table 3 shows the estimated expenditure and own-price elasticities under the unrestricted and each separable structure. In unrestricted expenditure elasticity, nine of the 18 sub-groups have values greater than 1, indicating they are superior and luxury goods. In particular, housing goods, furniture services, clothing services, and transportation and communication goods have noticeably higher values. Seven sub-groups, including housing services, furniture goods, and clothing goods, have values smaller than 1 and are necessities. The remaining two sub-groups have negative values and are considered inferior goods and necessities. In particular, the value of education goods stands out, indicating the magnitude of the impact of the under 29 and older age groups with few children in the household.

We also consider changes in expenditure elasticity under each separable structure. In the case of Structure 2, the results are relatively similar to the unrestricted case. For example, housing goods, fuel goods, furniture services, clothing service, medicine goods and services, and transportation and communication services are commonly superior goods and luxuries. In addition, recreation services and other goods are superior goods and necessities. On the other hand, Structure 1 shows a greater change in expenditure elasticity under a weak separable structure than the other structures. For example, fuel goods, medicine goods, and transportation and communication services have changed from luxuries to necessities. In addition, education and recreation services have changed from necessities to luxuries. Some sub-groups, such as housing goods, furniture goods, and medicine services, show common results under all separable structures. Structure 3 shows results relatively similar to those of the unrestricted case and Structure 2, but it also shows results in common with Structure 1. This can be expected, as the weakly separable structure of the utility function in (20) is partly similar to that of Structure 1. However, in Structure 3, we observe a change from superior to inferior goods in some sub-groups. Therefore, Structure 2 being relatively similar to the unrestricted case may be due to the fact that the weak separable structure of the utility function is originally derived on the basis of the unrestricted case. However, Structure 1 separates between goods and services, leading to different estimation results compared to the unrestricted case.

In all cases, own-price elasticity makes it difficult to satisfy the negative value condition for all sub-groups. In particular, housing and education services do not satisfy the negative value in any case. Under weak separability, Structure 2 show relatively satisfies the negative value condition in many cases. In all separable structures, fuel goods, medicine services, transportation and communication services, and recreation goods have values less than 1 and are price inelastic. In other words, the changes in these sub-groups in response to price changes are small. In addition, these sub-groups have an element of necessity for their own price but are often judged to be luxuries in expenditure elasticity. However, the values for housing goods are greater than 1 and these goods are price elastic. In other words, the change in the price of sub-group in response to price fluctuations is large. This is similarly to being luxuries in terms of expenditure elasticity. Furniture goods are price elastic under the unconstrained case and Structure 3 but become price inelastic under Structures 1 and 2. In other words, the results differ depending on the separable structure.

Table 3 Estimated elasticities in each separable structure

	Expenditure elasticity				Compensated own price elasticity			
	unrestricted	Structure1	Structure2	Structure3	unrestricted	Structure1	Structure2	Structure3
food:								
goods	0.964	0.892	1.535	1.690	-0.154	0.088	-0.146	-0.006
	(0.001)	(0.001)	(0.007)	(0.009)	(0.007)	(0.009)	(0.004)	(0.006)
services	-0.193	0.699	0.497	-0.094	0.0021	0.076	-1.753	0.025
	(0.025)	(0.006)	(0.010)	(0.022)	(0.019)	(0.019)	(0.015)	(0.019)
housing:								
goods	6.144	2.584	1.663	2.841	-1.720	-1.505	-2.452	-1.746
	(0.303)	(0.083)	(0.038)	(0.096)	(0.030)	(0.020)	(0.055)	(0.029)
services	0.445	-0.169	-0.454	-0.793	1.644	1.281	1.563	1.550
	(0.021)	(0.040)	(0.049)	(0.061)	(0.068)	(0.061)	(0.070)	(0.071)
fuel, light, and water charges:								
goods	1.323	0.859	1.901	1.651	-0.313	-0.238	-0.331	-0.290
	(0.005)	(0.002)	(0.013)	(0.010)	(0.007)	(0.009)	(0.006)	(0.007)
furniture and household utensils:								
goods	0.226	0.732	-0.199	0.449	-1.413	-0.378	-0.637	-1.400
	(0.021)	(0.007)	(0.030)	(0.014)	(0.010)	(0.012)	(0.009)	(0.010)

services	10.820	1.958	5.553	4.427	25.395	-0.226	-8.016	25.373
	(0.219)	(0.021)	(0.098)	(0.074)	(0.523)	(0.015)	(0.140)	(0.523)
clothing and footwear:								
goods	0.646	0.703	0.425	-0.162	0.162	0.337	0.326	0.121
	(0.005)	(0.004)	(0.009)	(0.017)	(0.015)	(0.018)	(0.018)	(0.016)
services	3.660	-0.451	2.114	0.416	10.644	1.936	-1.068	10.631
	(0.091)	(0.047)	(0.036)	(0.019)	(0.331)	(0.084)	(0.002)	(0.331)
medical care:								
goods	2.506	0.992	1.646	1.745	0.001	-0.071	-1.433	-0.015
	(0.024)	(0.001)	(0.010)	(0.011)	(0.013)	(0.013)	(0.007)	(0.019)
services	2.407	1.632	2.550	3.881	-0.279	-0.311	-0.408	-0.250
	(0.056)	(0.023)	(0.057)	(0.106)	(0.020)	(0.019)	(0.015)	(0.075)
transportation and communication:								
goods	4.809	4.909	-0.643	3.801	0.697	0.573	-1.518	0.666
	(0.281)	(0.267)	(0.112)	(0.192)	(0.074)	(0.069)	(0.025)	(0.075)
services	1.074	0.851	1.889	1.538	-0.079	-0.205	-0.347	-0.023
	(0.001)	(0.002)	(0.012)	(0.007)	(0.009)	(0.008)	(0.003)	(0.008)
education:								
goods	-4.492	1.603	3.443	-3.254	-19.539	8.249	-1.982	-19.538
	(0.249)	(0.247)	(0.100)	(0.174)	(1.961)	(0.978)	(0.104)	(1.961)
services	1.028	1.318	0.781	0.899	0.995	1.072	1.336	0.990
	(0.008)	(0.076)	(0.052)	(0.024)	(0.154)	(0.160)	(0.182)	(0.154)
culture and recreation:								
goods	0.783	1.668	1.556	1.739	-0.670	-0.390	-0.726	-0.556
	(0.016)	(0.043)	(0.036)	(0.047)	(0.007)	(0.012)	(0.004)	(0.005)
services	0.623	1.078	0.753	0.153	0.717	-1.296	-0.741	0.690
	(0.006)	(0.001)	(0.004)	(0.013)	(0.025)	(0.006)	(0.003)	(0.025)
other expenditure:								
goods	0.136	1.048	0.823	-0.390	0.584	-0.335	0.538	0.573
	(0.007)	(0.001)	(0.001)	(0.011)	(0.013)	(0.005)	(0.012)	(0.013)

Note: The standard errors represent the values calculated from the jackknife variance estimator. Estimated elasticities were calculated by imposing homogeneity and symmetry restrictions. Table 3 reports only own-price elasticities, but cross-price elasticities can also be disclosed upon request.

5.3 Robustness test by the generalized composite commodity theorem

Here, we use the GCCT of Lewbel (1996) to demonstrate the robustness of the above analysis by confirming its consistency with the weak separability results in Table 2. The GCCT justifies considering a group of commodities as an aggregation of commodities without assuming weak separability. This assumes that the group total expenditures are considered an aggregation of commodities as long as the variation in relative prices within the group is random and uncorrelated with the group price index. As the GCCT is said to simplify the test of weak separability (Reed, William, and Hallahan, 2005), testing the validity of this assumption would demonstrate the robustness of the above results. In addition, since the parametric weak separability test depends on the functional form, it is useful to verify under the GCCT whether the test is valid even when the functional form is not used. While the usual GCCT test often verifies the aggregation from the individual commodity level to the group, our analysis is not up to the individual commodity level but only covers aggregation at the sub-group level. Table 4 shows the test results of the GCCT according to the weakly separable structures in Table 2. This test was performed for individual sub-groups according to Schulz et al. (2012).[5] The hypothesis for the relationship between the cointegration test and the verification of the GCCT is that the GCCT is satisfied, or more precisely, that the relative prices in the aggregate sub-group are not correlated with the group index. In other words, whether the GCCT is satisfied depends on whether the relative prices are independent of the group index.

First, we conduct unit root tests for the group price index and relative prices of the sub-group. Table 4 shows the panel unit root test results for group price index R_I for $I = 1, \dots, R$ and relative prices ρ_i for $i = 1, \dots, N$. The panel unit root test is conducted by the method of Im, Pesaran, and Shin (2003), which assumes an individual unit root for all cross-sections. In Separable structure 1, the null hypothesis of an individual unit root in the constant and time trend case was not rejected at the 5% level, and both group indices R_I for goods and service and relative prices ρ_i were determined to have a unit root for all variables. Second, as confirmatory analysis, the test of stationarity of Hadri (2000) is performed. The null hypothesis of no unit root was rejected at the 5% level for all group indices R_I and relative prices ρ_i. In Separable structure 2, the null hypothesis of unit root was not rejected for all relative prices, but the null hypothesis was rejected for group indices R_I for housing and clothing. However, the test for stationarity rejected the null hypothesis of no unit root for both. In other words, both I(0) and I(1) are rejected, and no decision is made. One reason for the rejection of the unit root test for some of these variables may be a statistical power problem due to the small number of cross-sections. Following Table 2 in Davis et al. (2000), when relative price ρ_i is nonstationary and group index R_I is indeterminate, we test for independence by using a cointegration test. Of course, if both group index R_I and relative price ρ_i are nonstationary, we proceed with the cointegration test and perform the independence test. In Separable structure 3, the null hypothesis of unit root for nonstationary was not rejected at the 5% level for all group indices and for relative prices

[5] Davis et al. (2000) performs family-wise tests.

excluding food and fuel goods. However, the null hypothesis of no unit root for stationarity was rejected for all group indices and relative prices. For the relative prices of food and fuel goods, this is the same as for Structure 2, where both I(0) and I(1) was rejected and no decision was made.

In the unit root test, we assumed an individual unit root for all cross-sections. In the cointegration test, we adopted the method of Pedroni (2004), which follows the assumption of allowing for heterogeneity in the cointegrating vectors for the cross-sections. The results of the cointegration test first show that the null hypothesis of no cointegration between the group index of goods or services and the relative price in sub-group was not rejected in Separable structure 1. In other words, each relative price in sub-group is independent of the group index of goods or services and the GCCT is satisfied. Second, in Separable structure 2, the null hypothesis of no cointegration between each group index and the relative price of goods or services in the corresponding group was not rejected. In other words, the relative price of a good or service in the corresponding group is independent of each group index and the GCCT is satisfied. Finally, in Separable structure 3, the null hypothesis of no cointegration between the group index and each relative price was not rejected. In other words, each relative price in the corresponding group is independent of the group index and the GCCT is satisfied.

The unit root tests for Structures 2 and 3 provided neutral results for some group indices or relative prices, but the cointegration tests confirmed the independence of all relative prices for the group indices. In other words, the GCCT was satisfied for all structures. Therefore, we find that the GCCT-based validation results for Separable structures 1–3 are consistent with the weak separability results in Table 2. In other words, from the perspective of testing the weak separability of preferences between goods and services, aggregates consisting only of goods and aggregates consisting only of services are valid for Japanese households.

Table 4 Generalized composite commodity theorem test

	IPS test[a]	Hadri I(0) test[b]	Pedroni-ADF test[c]		IPS test	Hadri I(0) test	Pedroni-ADF test
Separable structure 1:							
R_{goods}	2.850	3.866	-	R_{service}	1.645	6.010	-
	(0.998)	(0.000)			(0.950)	(0.000)	
ρ_1	1.446	6.747	-0.725	ρ_2	7.706	7.826	0.296
	(0.926)	(0.000)	(0.234)		(1.000)	(0.000)	(0.616)
ρ_3	3.790	7.742	-1.478	ρ_4	-1.126	8.285	0.638
	(0.999)	(0.000)	(0.070)		(0.130)	(0.000)	(0.738)
ρ_5	3.999	3.022	-1.218	ρ_7	-0.980	6.602	-1.084
	(1.000)	(0.001)	(0.112)		(0.164)	(0.000)	(0.139)
ρ_6	0.069	5.071	0.593	ρ_9	8.691	8.150	-1.307

	(0.528)	(0.000)	(0.724)		(1.000)	(0.000)	(0.096)
ρ_8	3.687	8.634	-0.971	ρ_{11}	1.315	2.551	2.045
	(0.999)	(0.000)	(0.166)		(0.906)	(0.005)	(0.979)
ρ_{10}	-1.183	7.296	1.007	ρ_{13}	3.186	6.970	-0.358
	(0.119)	(0.000)	(0.843)		(0.999)	(0.000)	(0.360)
ρ_{12}	0.130	2.610	2.937	ρ_{15}	6.241	8.294	1.106
	(0.552)	(0.005)	(0.998)		(1.000)	(0.000)	(0.866)
ρ_{14}	7.378	5.970	1.404	ρ_{17}	1.789	2.702	3.727
	(1.000)	(0.000)	(0.920)		(0.963)	(0.003)	(0.999)
ρ_{16}	0.318	2.186	2.531	ρ_{19}	3.342	3.899	-0.604
	(0.625)	(0.014)	(0.994)		(0.999)	(0.000)	(0.273)
ρ_{18}	2.929	3.307	1.885				
	(0.998)	(0.000)	(0.970)				
Separable structure 2:							
R_{Food}	-0.303	2.195	-	$R_{\text{Transport}}$	2.161	6.352	-
	(0.380)	(0.014)			(0.985)	(0.000)	
ρ_1	1.712	4.948	2.169	ρ_{12}	-1.312	7.872	4.206
	(0.957)	(0.000)	(0.985)		(0.095)	(0.000)	(1.000)
ρ_2	0.105	6.955	2.275	ρ_{13}	1.245	7.683	2.562
	(0.542)	(0.000)	(0.989)		(0.894)	(0.000)	(0.995)
R_{Housing}	-5.254	4.893	-	$R_{\text{Education}}$	2.575	6.917	-
	(0.000)	(0.000)			(0.995)	(0.000)	
ρ_3	5.009	6.208	-1.205	ρ_{14}	4.048	7.052	0.819
	(1.000)	(0.000)	(0.114)		(1.000)	(0.000)	(0.793)
ρ_4	0.209	6.894	-0.965	ρ_{15}	2.203	7.489	-0.736
	(0.583)	(0.000)	(0.167)		(0.986)	(0.000)	(0.231)
$R_{\text{Furniture}}$	2.825	2.587	-	$R_{\text{Recreation}}$	2.885	3.689	-
	(0.998)	(0.005)			(0.998)	(0.000)	
ρ_6	-0.667	3.166	-1.372	ρ_{16}	0.639	3.086	2.543
	(0.252)	(0.000)	(0.085)		(0.739)	(0.000)	(0.995)
ρ_7	6.351	6.293	-0.883	ρ_{17}	7.406	6.506	-0.606
	(1.000)	(0.000)	(0.189)		(1.000)	(0.000)	(0.272)
R_{Clothing}	-1.875	3.972	-	R_{Other}	1.448	5.472	-
	(0.030)	(0.000)			(0.926)	(0.000)	
ρ_8	4.795	3.094	-0.304	ρ_{18}	8.868	8.154	-0.099
	(1.000)	(0.000)	(0.380)		(1.000)	(0.000)	(0.460)

ρ_9	5.039	4.061	4.213	ρ_{19}	6.273	6.865	-1.631
	(1.000)	(0.000)	(1.000)		(1.000)	(0.000)	(0.051)
R_{Medicine}	-0.739	6.786	-				
	(0.230)	(0.000)					
ρ_{10}	2.974	4.831	0.404				
	(0.999)	(0.000)	(0.657)				
ρ_{11}	1.898	4.363	-0.488				
	(0.971)	(0.000)	(0.313)				
Separable structure 3:							
$R_{\text{goods\_1}}$	2.103	2.775	-	R_{services}	1.646	6.006	-
	(0.982)	(0.003)			(0.950)	(1.000)	
ρ_1	-2.606	4.723	1.322	ρ_2	7.706	7.826	0.296
	(0.005)	(0.000)	(0.907)		(1.000)	(0.000)	(0.616)
ρ_3	6.111	6.821	2.198	ρ_4	-1.126	8.067	-0.630
	(1.000)	(0.000)	(0.986)		(0.130)	(0.000)	(0.264)
ρ_5	-2.049	5.123	1.152	ρ_7	-0.980	6.602	1.236
	(0.020)	(0.000)	(0.875)		(0.164)	(0.000)	(0.892)
$R_{\text{goods\_2}}$	-1.061	3.424	-	ρ_9	8.691	8.150	-0.631
	(0.144)	(0.000)			(1.000)	(0.000)	(0.264)
ρ_6	0.780	6.661	1.805	ρ_{11}	1.315	2.551	2.246
	(0.782)	(0.000)	(0.964)		(0.906)	(0.005)	(0.988)
ρ_8	7.607	7.248	2.013	ρ_{13}	3.186	6.969	-0.358
	(1.000)	(0.000)	(0.978)		(0.999)	(0.000)	(0.360)
ρ_{10}	-0.029	5.881	0.113	ρ_{15}	6.240	8.294	1.106
	(0.488)	(0.000)	(0.545)		(1.000)	(0.000)	(0.865)
ρ_{12}	0.345	2.731	2.293	ρ_{17}	1.789	2.702	3.960
	(0.635)	(0.003)	(0.989)		(0.963)	(0.003)	(1.000)
ρ_{14}	8.449	4.564	1.246	ρ_{19}	3.899	3.342	-0.385
	(1.000)	(0.000)	(0.894)		(0.000)	(0.999)	(0.350)
ρ_{16}	0.814	2.234	1.328				
	(0.792)	(0.012)	(0.908)				
ρ_{18}	3.691	2.952	-0.936				
	(0.999)	(0.002)	(0.175)				

Note: The numbers in parentheses represent p-values.

[a] The test statistics of the null hypothesis of I(1) is the W-statistics of Im, Pesaran, and Shin (2003) (IPS) of the lagged level variable in the regression of the differenced variable on the constant and time

trend, and the differenced variable of maximum lag of 12.

[b] The test statistics of the null hypothesis of I(0) is the *Z*-statistics of Hadri (2000) calculated using the KPSS statistics of Kwiatkowski et al. (1992), which is the sum of squared partial sums of residuals divided by an error variance estimator regressing the variable on the constant and time trend.

[c] The test statistics of the null hypothesis of no cointegration between the relative price and group index is calculated based on the augmented Dickey-Fuller test of the residual regressing the relative price on group index, a time trend, and the lagged first-difference residual of maximum lag of 6.

6. Conclusion

This study has examined the weak separability of preference between goods and services against the economic background of the transition of consumer demand from goods to services in Japan. To test for this, we first performed parametric tests using the QUAIDS model of Banks, Blundell, and Lewbel (1997). The three hypotheses used in this test are: a simple test of the weak separability between goods and services, a hypothesis that separates goods and services within each of the original statistical major category, and a hypothesis derived from the first that further separates the goods group into two.

Likelihood ratio tests were performed on the above three hypotheses, and all hypotheses were not rejected at the 5% significance level. As a result, we showed that the weak separability of preference between goods and services is established. This means that Japanese households regard goods and services separately and determine their preferences between goods or services. One possible reason for the transition in consumer demand from goods to services is that consumers allocate more of their expenditure to services when determining total expenditure. There may be various factors behind consumers' choice of services, such as the improvement of communication services due to the spread of the Internet and the diversification of culture and recreation services. In the second hypothesis, we showed that the composition of goods and services within 10 major categories is established. This indicates that it is possible to compose goods and services in the statistical classification of the 10 major categories. In the third hypothesis, food goods, housing goods, and fuel, light, and water charges goods were separated from the remaining goods and services. Although there is a shift toward services, the allocation to these three goods is necessary to maintain living standards.

The establishment of the weak separability of preferences between goods and services also suggests that improvements in various services may increase consumption expenditures, for example, the improvement of high-speed telecommunication services such as 5G and the expansion of travel support by the Japanese government. For goods, it is important to encourage increasing budget share allocations for goods that maintain living standards, such as food, housing, and fuel, light, and water charges. In addition, since consumers are directly affected by the recent price hikes of these goods, the Japanese government's provision of benefits to low-income groups, which allocate a high budget share to their food goods, would be important.

Furthermore, this study also examined whether robustness can be obtained for both results using the GCCT of Lewbel (1996), which does not assume weak separability. Moreover, since the test for parametric weak separability depends on the functional form, it would be useful to verify it using the GCCT whether similar results can be also obtained without using the functional form. The GCCT test verifies that the relative prices of goods and services are independent with respect to the group index to which each belongs by a panel cointegration test. As in the case of the weak separability test, the GCCT was tested along the three structures and was satisfied in all structures. This means that the 19 sub-groups can be classified into goods and services aggregations. Furthermore, we show consistency with the results of the weak separability test.

In our study, the weak separability and GCCT tests by age group were not feasible due to data limitations. As in Figures 1(a) and (b), different timing for the shift from demand for goods to that for services can be observed for different age groups. This may affect the results of the test of weak separability by age group. As future research, age group analyses would be possible if micro-panel data become available. Furthermore, more accurate validation results can be obtained by examining aggregation from the individual commodity level to the group level in the GCCT test. Furthermore, a dynamic panel model would be necessary to verify the continued weak separability of goods and services in the future for Japanese households due to the declining birthrate and aging population.

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