Service Expenditure and Intertemporal Elasticity of Substitution in Japan*

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Abstract

In this paper, we employ a cointegration approach to empirically analyze consumer behavior related to service expenditure in Japan. The model we employ is a CRRA utility function considering service and non-durable expenditures. The ratio of service expenditure reached 50% in the 1980s in Japan, and it has been increasing. It indicates that service expenditure is an important factor in analyzing consumer behavior. The empirical results show that the intertemporal elasticity of substitution of service expenditure is positive, significant and greater than that of non-durable expenditure. These results are caused by the growing ratio of selective service expenditure.

Keywords: Service expenditure, intertemporal elasticity of substitution, cointegration

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1. Introduction

In this paper, we employ a cointegration approach to empirically analyze consumer behavior related to service expenditure in Japan.

The ratio of service expenditure to total consumption is considered to increase as economic growth is promoted. For example, the ratio of service expenditure reached 50% in the 1980s in Japan, and it increased after that, as shown in Fig. 1.

When we analyze consumption behavior with macroeconomics data, we usually focus on the intertemporal elasticity of substitution (hereafter, IES) because the parameter IES implies a relationship between the interest rate level, conventional instruments of monetary policy, and consumption expenditure. In particular, durable goods are considered to have positive and high IES because of their expensiveness and durability[1]. On the other hand, service expenditure cannot be accumulated and this character is the same as that of non-durable consumption goods. Therefore, economic conditions are not considered to influence the purchase of services and the service expenditure trend is stable. For this reason, utilizing data of service is regarded as inappropriate one in empirical studies focusing on IES[2].

However, the Bank of Japan (1998) claims that service expenditure is not stable because the ratio of service expenditure to total consumption is high and the consumption trend is not stable. The Bank of Japan (1998) states that “selective service expenditure” is not always necessity, and that expenditure for selective services fluctuates according to the economic conditions. Moreover, the trend of selective service expenditure is similar to that of durable consumption goods, which fluctuates according to the income trend, in other words, the economic conditions.

The Bank of Japan (1998) presents empirical results showing that service expenditure can be explained by the income factor and consumer confidence based on the sample period from 1976:Q2 to 1997:Q1.

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[1] For example, see Mankiw (1985) and Ogaki and Reinhart (1998a).
[2] The empirical study by Ogaki and Reinhart (1998a) performs estimation of Euler equation excluding service expenditure.

Figure 2 shows plots the expenditure for durable consumption goods and selective services in the 1990s and 2000s[3]. This figure shows that the fluctuation of expenditure for selective services is the same as that for durable consumption goods and that their growth slowed in the 1990s when the Japanese economy was in a recession. This feature implies that the expenditure for selective services is also adjusted according to the economic conditions, as is the case with durable goods.

Figure 3 shows the ratio of expenditure for selective services to that for total services[4]. This figure indicates that the percentage of selective service expenditure was about 60% in the 1980s and it reached about 75% in the 2000s.

Figure 2 and 3 reveal that the service expenditure situation continued after the 1990s as stated by the Bank of Japan (1998); the service expenditure has been adjusted by business trends and might have a positive and significant IES.

In this paper, we perform empirical analysis focusing on the IES of service expenditure with quarterly consumption data (Statistical National Account) from 1980:Q1 to 2006:Q4. Hansen and Singleton (1982), Hamori (1992) and Ogaki and Reinhart (1998a,b), utilize Generalized Methods of Moment (GMM) in order to estimate the Euler equation of consumption. But the ordinal Euler equation of consumption consists of stationary variables: the real rate of interest and the ratio of consumption at the present and the next term. And consumer behavior is assumed to be explained by stationary nuisance factors: preference shocks, liquidity constraint and others. Then, the point estimator obtained from a misspecified model without these factors might contain distortion. However, estimation of the model considering nuisance factors is troublesome.

Ogaki (1992) and Ogaki and Park (1998) developed a cointegration approach for estimating the Euler equation. In this approach, they employ an additive separable CRRA utility function, and solve the utility maximization

[3] The definition of selective services is shown in the note of Fig. 2.
[4] The details of the data are shown in a note of Fig. 3.

problem. Then, they derive the marginal rate of substitution (MRS) between two types of consumption goods and obtain a linear equation for estimating the intertemporal elasticity of substitution of these expenditures. We employed this cointegration approach in order to avoid the influence of the stationary nuisance factor. To the best of our knowledge, this paper is the first attempt to estimate the IES of service expenditure with a Euler equation.

In this paper, Section 2 shows how the model was derived. Section 3 presents the empirical analysis, and Section 4 discusses the results and presents the conclusion.

2. Model

Firstly, we set the additive separable CRRA utility function u_t as follows:

$$u_t = a\frac{C_{1t}^{1-1/\sigma_1}e^{\varepsilon_{1t}}}{1-1/\sigma_1} + \frac{C_{2t}^{1-1/\sigma_2}e^{\varepsilon_{2t}}}{1-1/\sigma_2} \cdots\cdots (1).$$

Here, C_{it} is expenditure for consumption good $i\,(i=1,2)$ at period t, a is the weight and σ_i implies the intertemporal elasticity of substitution of consumption goods i. And ε_{it} is the stationary preference shock of each C_{it}.

Then, the intertemporal budget constraint is written as

$$(1+r_{t+1})(Y_t - P_t^1 C_{1t} - P_t^2 C_{2t}) = P_{t+1}^1 C_{1t+1} + P_{t+1}^2 C_{2t+1} \cdots (2).$$

Here, P_t^i is the deflator of consumption good $i\,(i=1,2)$ at period t and r_t is the real interest rate.

Employing (1) and (2), we can obtain the following equation:

$$\frac{P_t^1}{P_t^2} = \frac{aC_{1t}^{-\frac{1}{\sigma_1}}}{C_{2t}^{-\frac{1}{\sigma_2}}} e^{\varepsilon_{1t}-\varepsilon_{2t}} \cdots (3).$$

And taking a logarithm of (3), it can be rewritten as follows:

$$\ln\left(\frac{P_t^1}{P_t^2}\right) = const. - \frac{1}{\sigma_1}\ln(C_{1t}) + \frac{1}{\sigma_2}\ln(C_{2t}) + (\varepsilon_{1t} - \varepsilon_{2t}) \cdots (4).$$

Equation (4) is the linear Euler equation. Here, *const.* includes weight a and $\varepsilon_{1t} - \varepsilon_{2t}$ is the error term. In this study, we utilize Equ. (4) as the model for estimation. And hereafter, we set Goods 1 as services and Goods 2 as non-durable goods.

3. Empirical Analysis

In this section, we show the data description firstly. Then, we perform the empirical analysis with time series data: unit root test, cointegration test and estimation of cointegrating vector with DOLS (Dynamic OLS: Stock and Watson 1993).

3.1 Data

We utilize data of expenditure for consumption (service and non- durable consumption goods) and their deflators taken from the Statistics National Account (SNA). Here, we utilize 93SNA published in 2008 by the Cabinet Office of the Japanese government. Per capita consumption is used in many studies and we also employ monthly population estimation (Ministry of Internal Affairs and Communication) following previous studies. We obtained an original data series, and performed seasonal adjustment by X-12ARIMA.

3.2 Unit root Test

Then, we performed the unit root test for the variables included in Equ. (4): $\ln(P_t^1/P_t^2)$, $\ln C_1$ and $\ln C_2$. And the procedure of the unit root test is Phillips= Perron test (Phillips and Perron 1988) considering the constant term.

The results of the test for the level of variables indicate that the null hypothesis of the unit root is accepted with a 5% significance level. And the results of the test for 1st difference show rejection of the null. Therefore, it is considered that these variables in Equ. (4) obey I(1) process. The results are shown in detail in Table 1. Considering constant and linear trends, only $\ln(P_t^1/P_t^2)$ and $\ln C_2$ are I(1) variables.

3.3 Cointegration Test

In the previous subsection, we show that all variables in Equ. (4) are I(1) variables. Then, we perform the cointegration analysis in Equ. (4) and it is more desirable. In this subsection, we perform three types of cointegration test: the residual-based cointegration test (Engle=Granger test) developed by Engle and Granger (1987), maximum eigenvalue test based on the Vector Error Correction Model (VECM) by Johansen (1988) and Johansen and Juselius (1990) and residual-based test considering a possible structural break in the cointegration vector (Gregory and Hansen 1996)[5].

For the Gregory=Hansen test, we consider only the structural shift in the constant term.

And as the specification of the model, we utilize Equ. (4) including a linear trend because $\ln(P_t^1/P_t^2)$ and $\ln C_2$ (relative price and non-durable consumption expenditure) are I(1) variables with a linear trend.

The empirical results of the Engle-Granger test show the rejection of the null of no cointegration in Equ. (4). The details are shown in Table 2. The test statistics are -4.908 with an augmented term with degree 0 detected by SBIC.

Next, we show the empirical results of the maximum eigenvalue test. Following this test, we obtain the results of acceptance of the null in which the cointegrating rank is 0 at most with 5% significance level. This result implies there is no cointegration vector among all or some of three variables. The details are shown in Table 3.

The empirical results with the cointegration test developed by Gregory and Hansen (1996) indicate the rejection of the null hypothesis of no cointegration with a possible break in the constant term with 5% significance level. The test statistics are provided by the -5.600(C-T model in Gregory and Hansen 1996) with no augmented term detected by SBIC.

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[5] The cointegration test developed by Gregory and Hansen(1996) is the procedure considering a *possible* break point in cointegrating vector. And thus, rejection of the null of no cointegration does not always imply the existence of a break in the cointegration vector.

3.4 Estimation of the Cointegration Vector

In the previous subsection, we show the existence of one cointegration vector in the linear Euler equation with non-durable and service expenditure in Japan by the residual-based cointegration test. Now, we verify the point estimator of the cointegration vector in this Euler equation.

Usually, when a regression consisting of I(1) variables has a cointegration vector, point estimators are super-consistent with T-convergence. However, we have to estimate them adjusting the correlation between the error term and independent variables: the existence of endogeneity. Moreover, serial correlation and heteroskedastisity have certain effects on the *t*-values of point estimators via their standard errors.

Therefore, we have to consider these problems when we verify the cointegration vector so we employ the Dynamics OLD (DOLS) developed by Stock and Watson (1993), in order to avoid the problem of endogeneity. And we utilize Newey and West (1987)'s variance-covariance matrix in order to modify the standard error influenced by serial correlation and/or heteroskedastisity.

In order to perform the DOLS, we add leads and lags of augmented terms, which consist of 1st difference of independent variables. Then, if the correlation between augmented terms and error term is the main cause of endogeneity; adding these leads and lags can be a solution to this problem. The model for estimation is as follows:

$$\ln\left(\frac{P_t^1}{P_t^2}\right) = const. - \frac{1}{\sigma_1}\ln(aC_{1t}) + \frac{1}{\sigma_2}\ln(C_{2t})$$
$$+\sum_{i=-p}^{p}\gamma_{1i}\Delta\ln C_{1,t-i} + \sum_{i=-p}^{p}\gamma_{2i}\Delta\ln C_{2,t-i} + (\varepsilon_{1t} - \varepsilon_{2t})\cdots(5).$$

Here, γ_{1i} and γ_{2i} are coefficients of leads and lags. And i implies the length of leads and lags and we set $i = 1$ because of the short sample periods. When we consider dummy variable, D_τ , which explains the shift of the constant term, the model is as follows:

$$\ln\left(\frac{P_t^1}{P_t^2}\right) = const. + \gamma_D D_\tau - \frac{1}{\sigma_1}\ln(aC_{1t}) + \frac{1}{\sigma_2}\ln(C_{2t})$$

$$+\sum_{i=-p}^{p}\gamma_{1i}\Delta\ln C_{1,t-i} + \sum_{i=-p}^{p}\gamma_{2i}\Delta\ln C_{2,t-i} + (\varepsilon_{1t} - \varepsilon_{2t})\cdots(6).$$

The estimation results of DOLS show that the (reciprocal of) IESs are positive and significant considering the shift in the constant term. In this estimation, we modify the standard error with Newey and West (1987)'s variance-covariance matrix. And they also show that the IES of expenditure for service is larger than that of expenditure for non-durable consumption goods[6]. On the other hand, without considering the shift of the constant, the estimated IES of service expenditure is not significant. The details are shown in Table 5.

4. Conclusion

In the previous section, we estimate the linear Euler equation considering expenditure on services and non-durable goods in Japan from 1990:Q1 to 2006:Q4. These empirical results show that a cointegration relation exists in the Euler equation following Gregory and Hansen (1996)'s procedure, and that IES of consumption is both positive and significant with a shift of constant term. Moreover, the IES of service expenditure is higher than that of non-durable consumption.

These results indicate that service expenditure was influenced by the economic conditions and the interest rate level after the 1990s in Japan. This phenomenon may be due to the higher weight of selective service expenditure, which tends to react to the economic conditions, as shown in Figs. 2 and 3.

The sample period we employ is 1990-2006, and the Bank of Japan adopted a zero interest rate policy from 1999-2000 and 2001-2006. But the real interest rate, which is considered in the model, still fluctuated under the zero interest rate policy. And thus, these empirical results on IES to the real interest rate seem to make a certain contribution.

These empirical results support the hypothesis that the IES of service

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[6] We have to notice that the results of point estimates are reciprocal of IESs.

expenditure in Japan is positive and significant; we can apply the Euler equation for service expenditure in the 1990s and 2000s in Japan. The intertemporal elasticity of substitution is a parameter that implies the degree of the response of consumption to the interest rate, a conventional instrument of monetary policy. Our empirical results suggest that we should consider service expenditure, which accounts for more than 50% of consumption in Japan, when analyzing consumers' behavior and the effects of monetary policy on consumption.

Our empirical results show that the intertemporal elasticity of substitution of service expenditure is both positive and significant; however, these results are caused by the existence of selective service expenditure. As selective service expenditure includes luxury services, the significance and sign of IES will alter depending on the income level and the countries of the sample. We will compare IESs at different income levels and in different countries as future works.

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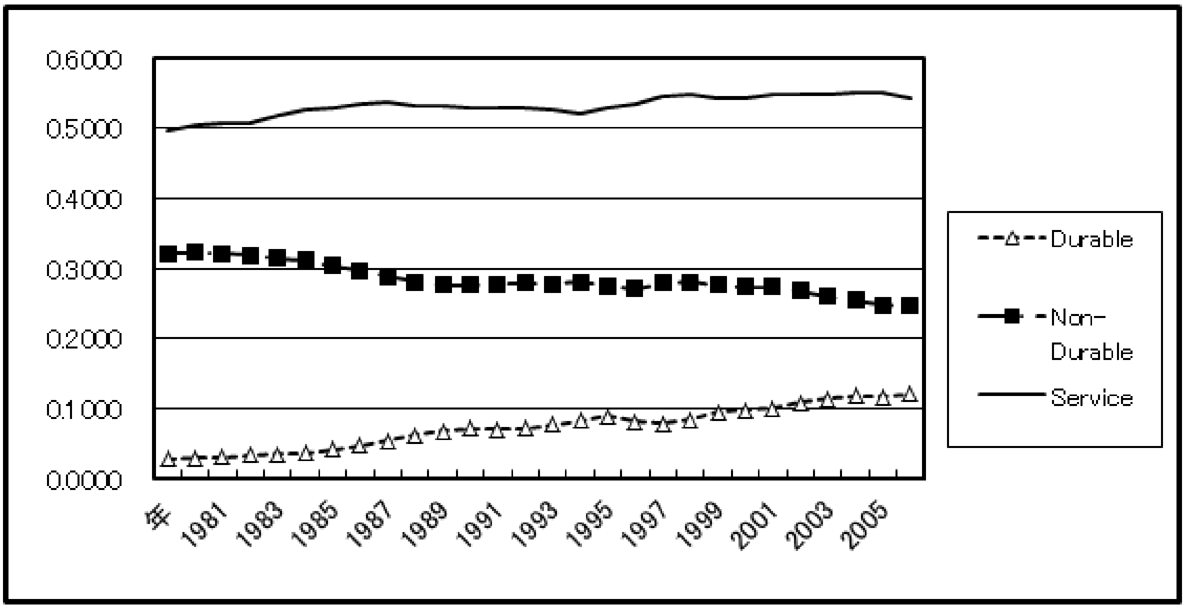
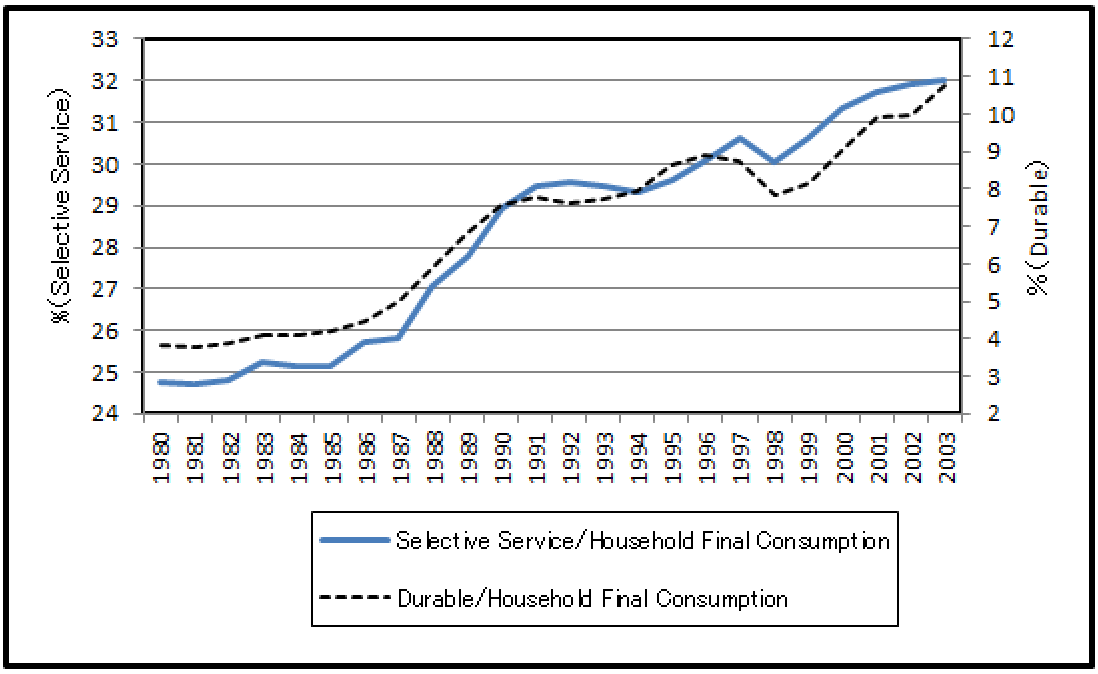
Figure 1 Ratio of Each Consumption Expenditure to Domestic Consumption



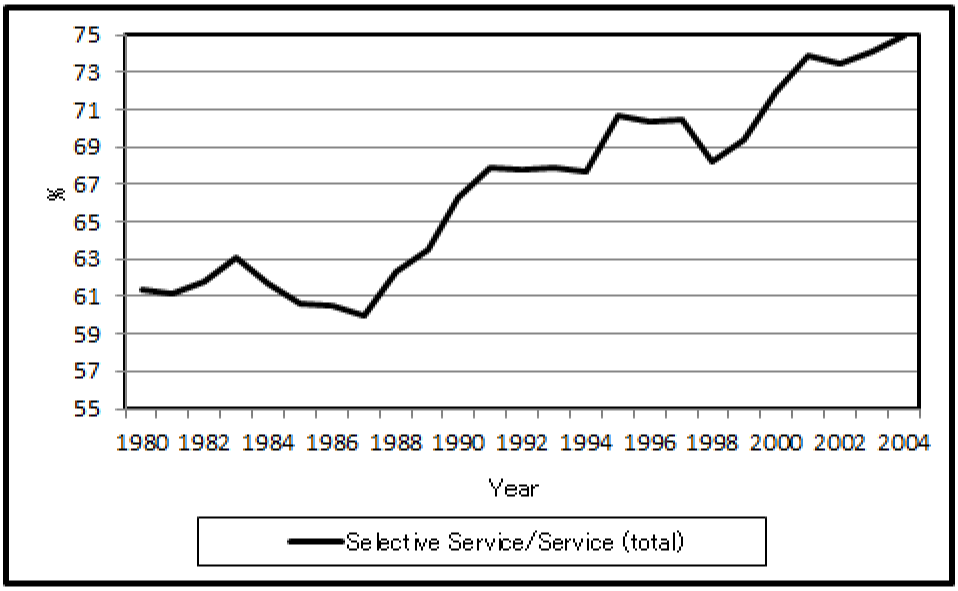
Source: Statistical of National Account 2008, “Classification by ‘type of Households Consumption Expenditure’ ”Annual, Real (Chained) Consumption

Figure 2: Selective Service Expenditure and Durable Consumption Goods Expenditure



(Note) We obtained data of durable goods expenditure and household final consumption expenditures from SNA (published in 2008 by Cabinet Office, annual, chained). The selective service expenditure consists of eating out, construction and other services, housework service, transportation and telecommunication, clothing services and cultural-amusement services taken from the household survey conducted by the Ministry of Internal Affairs and Communications. They are deflated by CPI.

Fig.3: The Ratio of Selective Services in Total Service Expenditure



(Note) We obtain data of service expenditure from household final consumption expenditures by category in SNA (published in 2008, annual, chained). The source of the selective service expenditure is the same as that in Fig.3. We exclude insurance premium, medical expense and imputed rent because they are handled differently in the SNA and household survey.

Table 1 Unit Root Test (Phillips-Perron test)

With const.	**lnP (Price)**	**ND (Non-Durable)**	**SEV (Service)**
X	-1.790(4)	-2.501(2)	-0.009(11)
ΔX	-8.731(4)***	-12.911(1)***	-15.757(9)***

(Note)*** denotes rejection at a significance level of 1%(Critical Value= -3.510), and ** donotes 5%(C.V.=-2.890) (C.V. are shown in Fuller (1976) and they are the case of T=100)

Table 2 Cointegration Test

(Engle-Granger test)

Test Statstics
-4.908(0)***

(Note)*** denotes rejection at a significance level of 1%, and ** donotes 5%. C.V. are 4.650(1%) and -4.160(5%) (Phillips and Ouliaris 1990) . The linear trend is included in the cointegration vector. The numbers in the parentheses are the lag length following SBIC.

Table 3 Cointegration Test (Maximum Eigenvalue Test)

Null (rank=number of cointegrating rank)	Test stat.	Critical value(5%)	*P*-value
rank=0	23.869	25.853	0.089
rank≤1	15.178	19.387	0.184
rank≤2	7.310	12.518	0.313

(Note) C.V. are shown in MacKinnon(1999). The linear trend is included in the cointegration vector. The number of the lag length is 1 following SBIC.

Table 4 Cointegration Test

(Gregory-Hansen Test)

	Test stat.	Break
CT-model	−5.600 (0)**	1996:Q2

(注)C.V. are -5.80 (1%) and -5.29 (5%) (Gregory and Hansen(1996), Table 1, m=2)

The linear trend is included in the cointegration vector (CT-model).

** denotes rejection at a significance level of 5%. The numbers in the parentheses are the lag lengths following SBIC.

Table 5 Point Estimator of Cointegration Vector by DOLS

<with trend>	$1/\sigma_{ND}$	$1/\sigma_{SERV}$
Estimated values (Modified *t*-value)	1.174(15.291)***	0.124(0.644)
<with trend, shift in constant>		
Estimated values (Modified *t*-value)	1.035(11.822)***	0.443(2.082)**

(Note) Here, *t*-values are modified with Newey and West(1987)'s variance-covariance matrix. The length of leads and lags is 1.

*** denotes rejection at a significance level of 1%, and ** denotes 5%.