Time-Series Properties and Demand System of Household Expenditure on Culture in Japan

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Abstract This study applies time-series econometrics to analyze the properties of household expenditure on culture in Japan. After preliminary investigation by implementing tests of unit roots and cointegration, an Almost Ideal Demand System (AIDS) with error correction terms is estimated for monthly household cultural and recreational expenditures. These expenditures include admission fees for movies and plays, cultural establishments, amusement parks, and other activities. Restriction of homogeneity and symmetry for parameters in AIDS are also tested. Using estimated parameters in the system, both long- and short-term price and income elasticity for cultural expenditures are calculated, which provides information on the properties of cultural expenditures in Japan.

Keywords: *Cultural expenditure, Almost Ideal Demand System, Error correction model, Income and price elasticity*

JEL Classification: *C32, D12, Z10*

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1 Introduction

Almost all economic indicators, including culture-related variables, are definitively affected by business cycles. In Japan during the early 1990s, for example, average expenditures to support the arts (*mécénat* activities) decreased after the bubble economy of the late 1980s burst. We can surmise that a similar situation pertains to cultural demand, such as household cultural expenditures[1].

The effect of business cycles on cultural expenditures can be considered to be expressed through fluctuations in income and price. The better the business cycle, the more the income is expected to increase; indeed, many authors have found, either theoretically or empirically, that income is among the major factors affecting cultural demand as well as price. Katsuura (2012) focused on the relationship between business cycles and cultural expenditures using the regime switching model, and found the relationship to be partly explained by income elasticity fluctuations. This paper provides quantitative results for income and price elasticity for cultural expenditures.

A certain number of articles on cultural demand, in which elasticity of income and/or price is estimated, have been published. Previous empirical studies of cultural demand mainly focused on the estimation of demand functions, which mainly modeled the relationship between cultural demands and their determinants such as income, price, and population. Contemporary demand analyses are closely related to Baumol and Bowen (1966). Income/price elasticity of cultural demand or participation has been discussed in relation to many countries, periods, items of cultural demand, models, etc. Seaman (2006) provided an excellent survey of this field by summarizing the quantitative results of elasticity. Moore (1966), Houthakker and Taylor (1970), Withers (1980), and Gapinski (1986) are typical examples of the earliest works.

However, most of the models used are *ad hoc*, which means that those models are not formally induced from the economic theory. One of the exemptions is Pommerhene and Kirchgassner (1987)—who estimated the system of demand functions based on the Almost Ideal Demand System (AIDS), developed by Deaton and Muellbauer (1980). Many applications and methodological studies on AIDS have been published in several fields of economics. However, in cultural economics, few studies have employed AIDS.

The econometric methodology in AIDS has been developed from various viewpoints. A recent discussion in AIDS involves the application of time-series econometrics, which incorporates nonstationary time-series analysis such as unit roots and cointegration into the system. AIDS with time-series econometrics, often referred to as dynamic AIDS, has also been applied to some areas of economics, such as agricultural economics (food demand) and tourism economics (tourism demand). By using dynamic AIDS, Karagiannis and Velentzas (1997), Karagiannis *et al.* (2000), and

[1] Katsuura (2012).

Katranidis and Mergos (2002) empirically analyzed food demand in Greece, Eakins, and Gallagher (2003) for alcohol expenditure in Ireland, and Duffy (2003) for food, drink, and tobacco in the United Kingdom. In tourism economics, Durbarry and Sinclair (2003), Li *et al.* (2004), De Mell (2005), Chang and McAleer (2012), and Koike and Yoshino (2014) applied dynamic AIDS to tourism demand data.

This paper utilizes dynamic AIDS to estimate cultural demand in Japan, which might be the first study. The remainder of the paper is organized as follows. Section 2 outlines the methodology and models used in this paper. Section 3 presents data involving cultural expenditures and tests conducted on their basic time-series properties. In Section 4, AIDS with an error correction model is estimated and income/price elasticity is calculated. The final section presents a brief conclusion.

2 Dynamic Almost Ideal Demand System and Cointegration

2.1 Almost Ideal Demand System

AIDS, developed by Deaton and Muellbauer (1980), is one of the most widely used models in consumer demand analysis because of its attractive features of simplicity, theoretical consistency, and relative ease of estimation[2].

In the AIDS demand function, budget shares are formulated as follows:

$$(1) \quad w_i = \alpha_i + \sum_{j=1}^{m} \gamma_{ij} \ln p_j + \beta_i \ln \frac{x}{P} \ ,$$

where w_i is the budget share of the *i*th commodity; p_j is the price of the *j*th commodity; m is the number of commodities in this system; x is the total expenditure of m commodities; and P is a price index, which is expressed as

$$(2) \quad \ln P = \alpha_0 + \sum_{i=1}^{m} \alpha_i \ln p_i + \frac{1}{2} \sum_{i=1}^{m} \sum_{j=1}^{m} \gamma_{ij} \ln p_i \ln p_j \ .$$

For parameters α, β, γ in Eq. (1), three restrictions are imposed for consistency with the economic theory, which take the following form:

(3) Adding-up restriction: $\sum_{i=1}^{m} \alpha_i = 1, \sum_{i=1}^{m} \beta_i = 0, \sum_{i=1}^{m} \gamma_{ij} = 0$

(4) Homogeneity: $\sum_{j=1}^{m} \gamma_{ij} = 0$

[2] Chang and McAleer (2012).

(5) Symmetry: $\gamma_{ij} = \gamma_{ji}$

To avoid high collinearity of price variables, a linear approximated (LA) model, often called LA-AIDS, is frequently used for its simplicity. Deaton and Muellbauer (1980) suggested using the Stone price index P^* [defined in Eq. (6)], instead of P

(6) $$P^* = \sum_{i=1}^{m} w_i \ln p_i \, .$$

2.2 AIDS with Cointegration

Recent developments in time-series econometrics of nonstationarity have had an impact on demand analyses, as well as other fields of economics, based on AIDS. The original AIDS does not distinguish between short- and long-run elasticity. The dynamic AIDS model incorporates error correction terms that are derived from residuals in cointegration equations. See Ng (1995), Balcome and Davis (1996), and Attfield (1997a, b) for examples of incorporating cointegration analysis into AIDS.

If we start from LA-AIDS, and variables have unit roots and are cointegrated in the same order, then AIDS can be rewritten as follows:

(7) $$\Delta w_i = \delta_i \Delta w_{i,t-1} + \sum_{j=1}^{m} \gamma_{ij}^s \Delta \ln p_{jt} + \beta_i^s \Delta \ln \frac{x_t}{P_t} + \lambda_i \mu_{it} + u_{it} \, ,$$

(8) $$\mu_{it} = w_{i,t-1} - \alpha_i - \sum_{j=1}^{m} \gamma_{ij} \ln p_{jt} - \beta_{ij} \ln \frac{x_t}{P_t} \, .$$

Equation (7) describes that current changes in budget shares, Δw_i, is explained by both current changes in prices and total real expenditure and the error correction term in the previous period, which is a deviation from long-run equilibrium. Equation (8) provides the long-run relationship, and long-run elasticity is calculated by coefficient estimates in Eq. (8). Short-run elasticity is calculated by the coefficient estimates in Eq. (7).

In estimating the dynamic AIDS described in Eqs. (7) and (8), Engle−Granger's two-step method is generally used. As the first step, Eq. (8) is estimated and the Augmented Dickey−Fuller test is implemented for residuals using an estimated Eq. (8), which corresponds to the cointegration test. Second, Eq. (7) is estimated by substituting Eq. (8) for μ_i in Eq. (7). See Karagiannis *et al.* (2000) for an advantage of Engle−Granger's two-step method for Johansen's maximum likelihood method.

2.3 Elasticity

Based on the model [Eqs. (7) and (8)], expenditure (income) and price elasticity are defined as follows[3]:

(9) income elasticity: $\eta_i = 1 + \frac{\beta_i}{w_i}$,

(10) Marshallian price elasticity: $\varepsilon_{ij}^M = -\delta + \frac{\gamma_{ij}}{w_i} - \frac{\beta_i}{w_i} w_j$,

(11) Hicksian price elasticity: $\varepsilon_{ij}^H = -\delta + \frac{\gamma_{ij}}{w_i} + w_j$,

where δ is the Kronecher delta. The differences in definitions of elasticity between AIDS and its linear approximated version have been discussed, and it was shown that some formulae are biased. See Green and Alson (1990, 1991), Alston *et al*. (1994), Buse (1994), and Asche and Wessels (1997) for details. Note that elasticity [Eqs. (9)–(11)] can be calculated for both short-run and long-run.

3 Data and Preliminary Tests

3.1 Data

This paper utilizes selected series from the Family Income and Expenditure Survey (FIES), which is conducted monthly by the Statistics Bureau, Ministry of Internal Affairs and Communications, Japan. The detailed commodity classification of FIES includes a selected list of cultural expenditures[4] by household, such as "admission fees for movies, plays, etc. (AFMP)," "admission fees for cultural establishments (AFCE)," and "admission fees for amusement parks (AFAP)." AFMP includes admissions to movies, theatres, concerts, comic storytelling, dinner shows, and kabuki. AFCE consists of admissions to art galleries, museums, zoos, temples and shrines, and other cultural facilities such as safari parks, aquariums, and botanical gardens, as well as to exhibitions of insects, dinosaurs, etc. These series belong to the broader item of "admission fees and game charges (AFGC)[5]." Therefore, we sum up other expenditures in AFGC, except these three items above, and this mixed expenditure is denoted as "other admission fees and game charges (OAFGC)." The following relation is holed in our notation and $m = 4$:

[3] Asche and Wessels (1997).
[4] Expenditures on cultural goods, such as musical instruments, cultural appliances (camera, audio sets, etc.), books, and CDs, are excluded. Here, we focus on expenditure on cultural services.
[5] Katsuura (2012).

$AFGC(x) = AFMP + AFCE + AFAP + OAFGC$ [6].

The corresponding price data from the Consumer Price Index (CPI), constructed by the Statistics Bureau, are used as price variables in AIDS. Although all items in CPI are selected on the basis of important expenditures in FIES, the raw price data in CPI do not always correspond to expenditures in FIES. For example, with regard to AFCE, only the price of admission to an art museum is utilized in CPI. The price index for OAFGC is calculated using the price indices of AFGC and three weighted CPI items.

Monthly series are available from both FIES and CPI. The sample period is from January 1995 to March 2014 because of the availability of CPI data for the items used. The monthly data are seasonally adjusted by Census X-12[7].

We focus on cultural expenditures that are classified within AFGC, and four items in AFGC are used in the subsequent analysis. Weak separability with respect to AFGC is assumed, which implies a two-stage budgeting process in consumer expenditures; that is, after the total expenditure of AFGC is allocated in the consumption expenditure, expenditures for four items in AFGC are decided by consumers.

3.2 Unit Root Test

The analysis aims to estimate Eqs. (7) and (8). The variables used in this analysis are expenditure shares and price indices of four items and real total expenditures deflated by the Stone price index. The Augmented Dickey−Fuller tests for all variables used are presented in Table 1. The results express both explained and explaining variables that have unit roots in level and are integrated in the same order, namely $I(1)$.

[6] See Appendix for categories in FIES.

[7] Since seasonally adjusted series are not published by the Statistics Bureau, we used the Census X-12 command in Eviews with default values.

Table 1. Result for Unit Root Tests

variable		level				first difference			
		α	t-value	P-value*	lag	α	t-value	P-value*	lag
budget share	w_{AFMP}	-0.0003	-0.0378	-0.0378	3	-2.3569	-14.8408	0.0000	0
	w_{AFCE}	-0.0005	-0.0527	-0.0527	4	-2.5114	-11.9482	0.0000	2
	w_{AFAP}	-0.2630	0.0548	-2.5781	3	-2.6658	-15.7845	0.0000	0
	w_{OAFGC}	-0.0025	-0.9072	-0.9072	3	-2.2579	-14.3163	0.0000	0
log price	$ln\ p_{AFMP}$	-0.1030	-3.2663	-3.2663	1	-1.3208	-21.0814	0.0000	0
	$ln\ p_{AFCE}$	-0.0276	-1.0452	-1.0452	3	-1.7764	-13.4936	0.0000	2
	$ln\ p_{AFAP}$	-0.0272	-1.7080	-1.7080	0	-1.0532	-16.0640	0.0000	0
	$ln\ p_{OAFGC}$	-0.0187	-1.4634	-1.4634	0	-1.0150	-15.3082	0.0000	0
log real expenditure	$ln\ x/P$	-0.1818	0.6232	-2.0196	7	-4.4239	-11.2530	0.0000	6

*MacKinnon (1996) one-sided p-values. Unit root test is based on the following equation:

$\Delta y_t = \delta_0 + \delta_1 t + \alpha y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + v_t$. Constant term, linear trend, and the order of lags depend on variables.

3.3 Cointegration Test

Table 1 indicates that the level variables are *I* (1); thus, we proceed to test for cointegration based on Eq. (12).

(12) $$w_{it} = \alpha_i + \sum_{j=1}^{m} \gamma_{ij} \ln p_{jt} + \beta_{ij} \ln \frac{x_t}{P_t^*} + u_{it} .$$

The Engle−Granger test is equivalent to the ADF test for the residual in Eq. (12), i.e., null hypothesis of no cointegration corresponds to a unit root test of the null of nonstationarity.

We estimate the system of Eq. (12) by Ordinary Least Squares (OLS), excluding the last equation for w_{OAFGC}, to keep the adding-up restriction [Eq. (3)]. The restrictions of homogeneity [Eq. (4)] and symmetry [Eq. (5)] are imposed in the estimation[8]. Using the residuals of Eq. (12), cointegration is tested on the basis of $\Delta u_t = \alpha u_{t-1} + \sum_{i=1}^{p} \beta_i \Delta u_{t-i} + v_t$; *t*-statistics ($\tau$) and *z*-statistics for α are shown in Table 2.

[8] We can test homogeneity and symmetry at this stage. Both restrictions are not rejected. The SUR method can be used for Eq. (12), but the following results are not seriously affected.

Table 2. Result for Engle-Granger Cointegration Tests

equation	τ	P-value*	z	P-value*
w_{AFMP}	-11.5829	0.0000	-169.9618	0.0000
w_{AFCE}	-11.1089	0.0000	-160.9561	0.0000
w_{AFAP}	-13.1929	0.0000	-201.9300	0.0000
w_{OAFGC}	-9.9855	0.0000	-140.3604	0.0000

*MacKinnon (1996) one-sided p-values.

Table 2 shows null hypothesis of no cointegration are rejected, which means that a long-run relationship for budget shares exists.

4 Empirical Results

4.1 Estimation of Dynamic AIDS

Since the cointegrated equation exists, the dynamic AIDS expressed by Eq. (7) is estimated. Again, we exclude the last equation for Δw_{OAFGC} to keep the adding-up restriction [Eq. (3)]. Zellner's seemingly unrelated regression (SUR) method is applied in the estimation to account for the contemporary correlation of u_i.

Homogeneity and symmetry of the parameters in Eq. (7) are tested using the Wald test. The test statistics χ^2 of null hypothesis of homogeneity and symmetry are 3.7068 and 1.9117, respectively. Corresponding P-values of χ^2 for degrees of freedom are 0.2949 and 0.5909, which means that homogeneity and symmetry are not rejected in dynamic AIDS[9].

Using the restriction of homogeneity and symmetry, the estimated parameters for Eq. (7) are reported in Table 3.

[9] Joint hypothesis of homogeneity and symmetry is not rejected, either.

Table 3. Estimated Parameters of Dynamic AIDS

	w_{AFMP}			w_{AFCE}			w_{AFAP}		
parameter	*estimates*	*s.e.*	*P-value*	*estimates*	*s.e.*	*P-value*	*estimates*	*s.e.*	*P-value*
γ_{i1}	-0.0950	0.3006	0.7520						
γ_{i2}	-0.0732	0.1179	0.5351	-0.1162	0.0891	0.1929			
γ_{i3}	-0.0621	0.1696	0.7143	0.0429	0.0855	0.6157	0.0151	0.1763	0.9317
γ_{i}	-0.0482	0.0151	0.0015	-0.0166	0.0079	0.0357	0.0242	0.0138	0.0795
δ_{i}	-0.4643	0.0431	0.0000	0.0747	0.0222	0.0008	0.0253	0.0390	0.5167
λ_{i}	0.7492	0.0508	0.0000	0.6635	0.0607	0.0000	0.8558	0.0643	0.0000
R^2	0.5867			0.3706			0.4478		
$adj\ R^3$	0.5775			0.3565			0.4354		
SE	0.0189			0.0098			0.0171		

Coefficients of determination are not too low for using monthly data. As expected from the cointegration tests, coefficients of the error correction term λ_i are statistically significant and positive.

4.2 Calculated Elasticity

The short-run Marshallian price and expenditure elasticity and Hicksian price elasticity, defined by Eqs. (9)−(11) and reported in Table 4, are calculated from the parameter estimates in Table 3 using the restriction of adding-up, homogeneity, and symmetry.

Table 4. Estimated Elasticity of Price and Expenditure

***a*. Marshallian Elasticity**

	AFMP	AFCE	AFAP	OAFGC	Expenditure
AFMP	-1.4116	-0.3374	-0.2791	1.2612	0.7670
AFCE	-0.9734	-2.6045	0.5682	2.1898	0.7677
AFAP	-0.7313	0.4490	-0.8594	-0.1223	1.2639
OAFGC	0.3521	0.2277	0.0005	-1.6447	1.0644

***b*. Hicksian Elasticity**

	AFMP	AFCE	AFAP	OAFGC
AFMP	-1.2531	-0.2825	-0.2087	1.7447
AFCE	-0.8147	-2.5495	0.6910	2.6737
AFAP	-0.4701	0.5395	-0.7434	-0.9018
OAFGC	0.5721	0.3040	-0.3257	-0.9738

Looking at expenditure elasticity, AFMP and AFCE are inelastic. When Marshallian own-price elasticity is considered, AFMP, AFCE, and OAFGC are price elastic, and AFCE elasticity is the largest. These observations are similar to Hicksian elasticity. This indicates that price is an important factor for cultural activities such as watching a movie/play or visiting a cultural place; however,

income is less influential. When the sign of cross elasticity of price is considered, AFCE and AFAP are found to be substitutes, which means visiting amusement parks and cultural institutions such as museums is competitive. However, AFMP and both AFCE and AFAP are complementary, since movies and plays do not directly compete with museums and amusement parks. Moreover, cross-elasticity of AFMP and AFCE to other expenditures is positive and large. This means cultural activities are substitutes for other entertainment expenditures.

5 Concluding Remarks

This paper estimates dynamic AIDS for Japanese cultural expenditures for the items of admission fees and game charges surveyed in FIES. This might be the first attempt for analyzing cultural demand in Japan using AIDS with an error correction model. Although relatively strong assumptions for two-stage budgeting are imposed, the results of elasticity seem to be valid for explaining the relationship between expenditures for cultural and other activities. The analysis can be extended to overall variables in consumption expenditure or by selecting different items in the system; however, formulation should be performed carefully.

Implications for some purposes may be derived and applied from these results. For example, Katsuura (2012) considered the correspondence of AFMP and AFCE to business cycles, and the results were explained by the difference of income elasticity during different business cycle phases. We can estimate time-dependent expenditure elasticity from Table 3. Detailed analyses and applications remain for future study.

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Appendix. Structure of Classification in the Family Income and Expenditure Survey

item	variable name
Consumption expenditures	
Food	
Housing	
Fuel, light & water charges	
Furniture & household utensils	
Clothing & footwear	
Medical care	
Transportation & communication	
Education	
Culture & recreation	
Recreational durable goods	
Recreational goods	
Books & other reading materials	
Recreational services	
Accommodation services	
Package tours	
Lesson fees	
Other recreational services	
Charges for TV licence	
Admission fees & game charges	AFGC
Admission fees for movies, plays, etc.	AFMP
Admission fees for cultural establishments	AFCE
Admission fees for amusement parks	AFAP
Admission fees for sports	OAFGC
Rental fees for sports facilities	
Other admission fees & game charges	
Membership dues	
Photo processing charges	
Hire of recreational goods	
Internet connection charges	
Others	
Other consumption expenditures	

Source: Statistics Bureau of Japan, Family Income and Expenditure Survey