Demand Estimation and Household's Welfare Measurement: Case Studies on Japan and Indonesia

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Abstract:

This paper aims to estimate households' demand function and welfare measurement under Linear Expenditure System (LES) in the case of Japan and Indonesia. In estimating the coefficients of the LES, this paper applies Seemingly Uncorrelated Regression (SUR) method. This paper gives some conclusions. *First,* for food consumption *Indonesian* households have the maximum marginal budget share on Meat and the minimum one on Fruits; meanwhile Japanese households have the maximum marginal budget share on Fish and shellfish and the minimum one on Dairy products and eggs. Indonesian households are 'meat lover' and Japanese households are 'fish lover'. *Second*, Indonesian households have smaller gap between minimum food consumption (subsistence level) and average food consumption than Japanese households have. *Third*, with the same level of price increase on foods the simulation shows that in nominal-term (Yen, ¥) Japanese households get greater welfare decrease than Indonesian households get. However, in the percentage of total food expenditure, Indonesian households get greater welfare decrease than Japanese households get. *Fourth,* it is estimated that during the period 2000-2004 the changes of prices in living expenditure increased both Japanese All Households and Japanese Worker Households more than ¥ 4,500.

Keywords: Linear Expenditure System (LES), Seemingly Uncorrelated Regression (SUR), Compensating Variation (CV), Equivalent Variation (EV).

1. INTRODUCTION

An individual household gets welfare (utility) from its consumption of goods and services, such as food, clothes, housing, fuel, light, water, furniture, transportation and communication, education, recreation and so on. The idea of standard of living relates to various elements of household's livelihood and varies with income. When income was low as in Japan in the 1950s this could be indicated mainly by the consumption level, especially of foods. After most of the households become able to meet basic needs in the 1960s, household consumption on semi-durable and durable goods became measure of the living standard (Mizoguchi 1995). How many goods and services the individual household might have access to depends very much upon many factors such as income, prices of goods (complementary and substitution), availability of goods in market, etc.

In the basic theory of microeconomics, it is assumed that the individual household aims to maximize its welfare (utility) subject to its income. The aim is achieved by determining the optimal number of goods and services (Mas-Colell et al., 1995). Therefore, some changes not only in prices of goods and services but also in the individual household's income will affect the individual household's welfare. As the income increased as high as he other developed countries in the 1970s, Japanese household's interest turned from current expenditure to financial and real assets for maintaining a stable life in the present and in the future. Further, in such a higher income level country as Japan, households start preferring leisure hours to overtime pay.

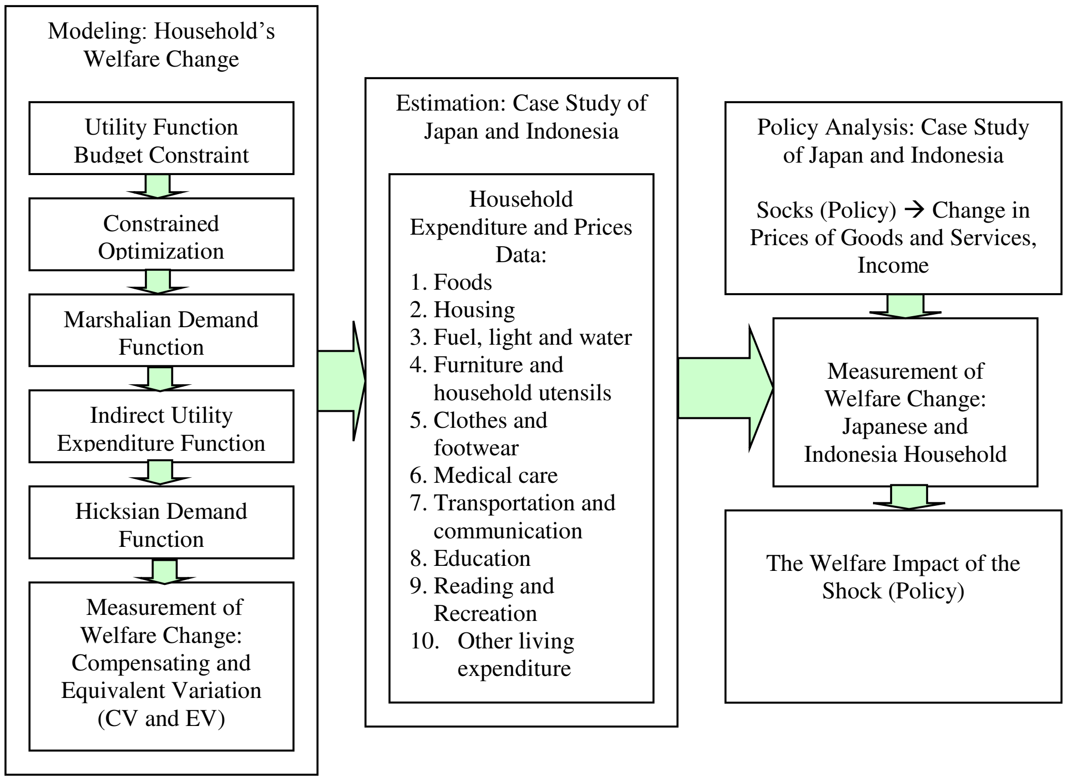
The prices of goods and services and income might be determined by market mechanism or government intervention. By market mechanism means that the prices of goods and services are determined by the interaction between market supply and demand. In market, the prices will decrease if supply is greater than demand (excess supply); in contrast, the prices will increase when demand is greater than supply (excess demand). The government might control the prices of goods and services for some reasons; such as equality in distribution, pro-poor government policy, floor and ceiling prices policy (for example in agricultural products: e.g. rice), efficiency, etc. The goods and services which the prices are determined by the government are sometimes called administrated goods (Tambunan 2001). In Indonesia, for example, the government determines the prices of fuel (*Bahan Bakar Minyak,* BBM), electricity, and regional minimum wages (Widodo, 2006). Based on the fact that the household's welfare is affected by the consumption of goods and services, estimating demand and welfare measurement of the individual household are very interesting to be analysed.

This paper has some objectives i.e. to derive a model of demand and welfare measurement of individual household; to estimate the model for Japanese and Indonesian case studies; to make some simulations from the estimations. The rest of this paper is organized as follows. Part 2 gives the theoretical framework that will be used in this paper. Data and estimation method are presented in part 3. Research findings will be presented in part 4. Finally, some conclusions are in part 5.

2. THEORETICAL FRAMEWORK

This research will estimate the measurement of household welfare-change and then use the estimation for analyzing the welfare impact of price changes due to such shocks as government policies, changes in the supply side, economic crisis, etc- in the case of Indonesia. Figure 1 shows the theoretical framework of this researh. The welfare analysis in this research is mainly derived from the household consumption. Theoretically, the household demand for goods and services is a function of prices and income (by definition of Marshallian demand function). Therefore, some changes in income and prices of goods and services will directly affect the number of goods and services and indirectly affect household welfare.

Figure 1. Theoretical Framework



2.1. Estimating Demand, Indirect Utility and Expenditure Function

To get the measurement of welfare change, we have to estimate the household expenditure function. For that purpose, some steps should be followed. *Firstly*, the household utility function should be established. In this paper, the household's utility function is assumed to be Cobb-Douglas function which can derive the Linear Expenditure System of demand (LES) (Stone, 1954). This assumption is taken because the LES is suitable for the household consumption/demand[1]. LES is widely used for some reasons (Intriligator et al 1996: 255). LES has a straightforward and reasonable interpretation and it is suitable for the household consumption/demand. LES is one of the

[1] For detailed information, see Barten (1977), Deaton and Muellbauer (1980), Philips (1993) and Deaton (1986).

few systems, which automatically satisfy all theoretical restrictions[2]. In addition, it can be derived from a specific utility function[3].

Secondly, the LES of household demand can be estimated by using available data. Therefore, the household (Marshallian and Hicksian) demand functions for each food commodity and service can be found. From the estimated demand function, we can derive the household indirect utility and expenditure function.

Finally, for the purpose of policy analysis the welfare change can be measured by comparing the household expenditure 'pre-shock' and 'post-shock' or 'before' and 'after' implementation of a specific government policy. These stages will be expressed in the next paragraphs.

Marshallian Demand System

In this paper, it is assumed that the households have a utility function following the more general Cobb-Douglas. Stone (1954) made the first attempt to estimate a system equation explicitly incorporating the budget constraint, namely the Linear Expenditure System (LES). In the case of developing country, the LES has been used widely in the empirical studies in India by some authors (Pushpam and Ashok, 1964; Bhattacharya, 1967; Ranjan, 1985; Satish and Sanjib, 1999).

Formally the individual household's preferences defined on n goods are characterized by a utility function of the Cobb-Douglas form. Klein and Rubin (1948)

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[2] Economic theory suggests that the demand functions must satisfy certain restrictions i.e. budget constraint condition, two homogeneity conditions (absence of money illusion and homogeneous degree zero), Slutsky condition (negativity and symmetry conditions) , aggregation condition (Engel and Cournot aggregation conditions) (Widodo, 2005).

[3] The specific utility function from which the linear expenditure system can be derived is the Stone-Geary utility function (also called the Klein-Rubin utility function). This utility actually is a modified Cobb-Douglas utility function.

formulated the LES as the most general linear formulation in prices and income satisfying the budget constraint, homogeneity and Slutsky symmetry. Samuelson (1948) and Geary (1950) derived the LES from representing the utility function:

$$U(x_1 \ldots\ldots\ldots x_n) = \left(x_1 - x_1^o\right)^{\alpha_1}\left(x_2 - x_2^o\right)^{\alpha_2}\left(x_3 - x_3^o\right)^{\alpha_3}\ldots\ldots\ldots\left(x_n - x_n^o\right)^{\alpha_n} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Individual household's problem is to choose the combination of x_i that can maximize its utility $U(x_i)$ subject to its budget constraint. Therefore, the optimal choice of x_i is obtained as a solution to the constrained optimization problem as follows:

$$\max_{x_i} \; U(x_i) = \prod_{i=1}^{n}\left(x_i - x_i^o\right)^{\alpha_i}$$

Subject to:

$\mathbf{PX} \leq M$

Where:

$\sum_{i=1}^{n} \alpha_i = 1$

$x_i - x_i^o > 0$

$0<\alpha_i<1$

Π is product operator

x_i is consumption of commodity i

x_i^o and α_i are the parameters of the utility function

x_i^o is minimum quantity of commodity i consumed

$i \in [1,2,3 \ldots\ldots n]$

P is a vector of prices

X is a vector of quantity of commodity

M is income

Solving the utility maximization problem, we can find the Marshallian (uncompensated) demand function for each commodity x_i as follows:

$$x_i = x_i^o + \frac{\alpha_i\left(M - \sum_{j=1}^{n} p_j x_j^o\right)}{p_i \sum_{i=1}^{n} \alpha_i} \quad \text{for all i and j} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Where: $i \in (1,2,\ldots\ldots n)$

$j \in (1,2,\ldots\ldots n)$

Since a restriction that the sum of parameters α_i equals to one, $\sum_{i=1}^{n} \alpha_i = 1$, is imposed, equation (2) becomes:

$$x_i = x_i^o + \frac{\alpha_i \left(M - \sum_{j=1}^{n} p_j x_j^o \right)}{p_i} \quad \text{for all i and j} \quad \ldots\ldots\ldots\ldots\ldots\ldots(3)$$

Equation (3) can be also reflected as the Linear Expenditure System as follows:

$$p_i x_i = p_i x_i^o + \alpha_i \left(M - \sum_{j=1}^{n} p_j x_j^o \right) \quad \text{for all i and j} \quad \ldots\ldots\ldots\ldots\ldots\ldots(4)$$

This equation system (4) can be interpreted as stating that expenditure on good i , given as $p_i x_i$, can be divided into two components. The first component is the expenditure on a certain base amount x_i^o of good i , which is the minimum expenditure to which the consumer is committed (*subsistence expenditure*), $p_i x_i^o$ (Stone, 1954). Samuelson (1948) interpreted x_i^o as a necessary set of goods resulting in an informal convention of viewing x_i^o as non-negative quantity.

The restriction of x_i^o to be non-negative values however is unnecessarily strict. The utility function is still defined whenever: $x_i - x_i^o > 0$. Thus the interpretation of x_i^o as a *necessary level of consumption* is misleading (Pollak, 1968). The x_i^o allowed to be negative provides additional flexibility in allowing price-elastic goods. The usefulness of this generality in price elasticity depends on the level of aggregation at which the system is treated. The broader the category of goods, the more probable it is that the category would be price elastic. Solari (in Howe, 1954:13) interprets negativity of x_i^o as *superior* or *deluxe* commodities.

In order to preserve the committed quantity interpretation of the x_i^o when some x_i^o are negative, Solari (1971) redefines the quantity $\sum_{j=1}^{n} p_j x_j^o$ as 'augmented supernumerary income' (in contrast to the usual interpretation as supernumerary income, regardless of the signs of the x_i^o). Then, defining n* such that all goods with i≤n* have positive x_i^o and goods for i>n* are superior with negative x_i^o, Solari interprets $\sum_{j=1}^{n^*} p_j x_j^o$ as *supernumerary income* and $\sum_{j=n^*+1}^{n} p_j x_j^o$ as *fictitious income*. The sum of 'Solary-supernumerary income' and fictitious income equals augmented supernumerary income. Although somewhat convoluted, these redefinition allow the interpretation of 'Solari-supernumerary income' as expenditure in excess of the necessary to cover committed quantities.

The second component is a fraction α_i of the *supernumerary income*, defined as the income above the 'subsistence income' $\sum_{j=1}^{n} p_j x_j^o$ needed to purchase a base amount of all goods. The coefficients α_i are scaled to sum to one to simplify the demand functions. The coefficients α_i are referred to as the *marginal budget share*, $\alpha_i / \sum \alpha_i$. It indicates the proportion in which the incremental income is allocated.

Indirect Utility

The indirect utility function V(**P**,M) can be found by substituting the Marshallian demand x_i (equation 3) into the utility function $U(x_i)$ (equation 1). Therefore, the indirect utility function is:

$$V(P,M) = \prod_{i=a}^{n} \left(\frac{\alpha_i \left(M - \sum_{j=1}^{n} p_j x_j^o \right)}{p_i} \right)^{\alpha_i}$$

for all i and j ………………………...………(5)

Expenditure Function

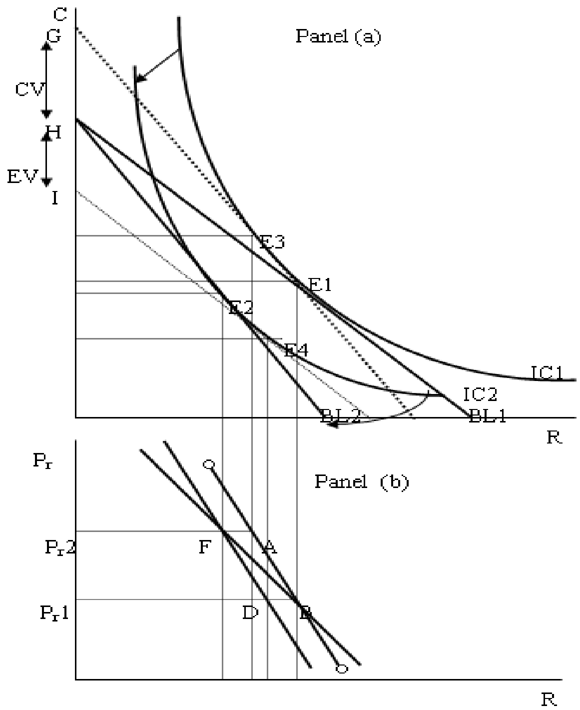
Equation (5) shows the household's utility function as a function of income and commodity prices. By inverting the indirect utility function the expenditure function E(**P**,U), which is a function of certain level of utility and commodity prices, can be expressed as follows:

$$E(P,U) = \frac{U}{\prod_{i=1}^{n}\left(\frac{\alpha_i}{p_i}\right)^{\alpha_i}} + \sum_{i=1}^{n} p_i x_i^o \quad \text{for all i and j} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(6)$$

2.2. Welfare Change

The Equivalent Variation (EV) and Compensation Variation (CV) will be applied to analyze the impact of the price changes due to any shocks or government policies. Figure 2 visualizes the EV and CV when there is only an increase in price of one good. The EV can be defined as the dollar amount that the household would be indifferent in accepting the changes in food prices and income (wealth). It is the change in household's wealth that would be equivalent to the prices and income change in term of its welfare impact (EV is negative if the prices and income changes would make the household worse off).

Figure 2. Compensating Variation (CV) and Equivalent Variation (EV)



EV and CV. Suppose C is composite goods and R is rice. Consider a household has income M that is spent for Rice (R) and Composite goods (C) at price P_c and P_r1, respectively. The budget line is shown by BL1. Suppose there is an increase in price of rice from P_r1 to P_r2. Therefore, the budget line becomes BL2. The household's equilibrium moves from E1 to E2. It derives the Marshallian demand curve FB (panel b). To get the original utility IC1, the household should be compensated such that BL2 shifts and coincides with IC1 at E3. The compensating variation is represented by GH in panel (a) or area P_r2ABP_r1 (panel b). The equivalent variation is represented by HI in panel (a) or P_r2FDP_r1 (panel b).

Meanwhile, the CV measures the net revenue of the planner who must compensate the household for the food prices and income changes, bringing the household back to its welfare (utility level) (Mas-Colell et al., 1995:82). The CV is negative if the planner would have to pay household a positive level of compensation because the prices and income changes make household worse off).

If there are changes in prices and income, the EV and CV can be formulated as:

$$EV = E(p^o, U^{'}) - E(p^{'}, U^{'}) + (M^{'} - M^o) \quad \text{...(7)}$$

$$CV = E(p^o, U^o) - E(p^{'}, U^o) + (M^{'} - M^o) \quad \text{......................................(8)}$$

In the context of the Linear Expenditure System (LES), equation (7) and (8) become:

$$EV = \left(\prod_{i=1}^{n} \left(\frac{p_i^o}{p_i^{'}} \right)^{\alpha_i} - 1 \right) M^o - \prod_{i=1}^{n} \left(\frac{p_i^o}{p_i^{'}} \right)^{\alpha_i} \sum_{i=1}^{n} p_i^{'} x_i^o + \sum_{i=1}^{n} p_i^o x_i^o + \left(M^{'} - M^o \right) \quad \text{........(9)}$$

$$CV = \left(1 - \prod_{i=1}^{n}\left(\frac{p_i^{'}}{p_i^{o}}\right)^{\alpha_i}\right)M^{o} - \sum_{i=1}^{n} p_i^{'} x_i^{o} + \prod_{i=1}^{n}\left(\frac{p_i^{'}}{p_i^{o}}\right)^{\alpha_i} \sum_{i=1}^{n} p_i^{o} x_i^{o} + \left(M^{'} - M^{o}\right) \quad \text{........(10)}$$

for all i and j.

Where:

p_i^{o} is the price of commodity i 'pre shock'

$p_i^{'}$ is the price of commodity i 'post shock'

U^0 is level of utility (welfare) 'pre shock'

U' is level of utility (welfare) 'post shock'

M^0 is income (expenditure) 'pre shock'

$M^{'}$ is income (expenditure) 'post shock'

3. DATA AND ESTIMATION

Data

Basically, estimating the LES model requires data on prices, quantities and incomes. For the case of Japan, this paper uses time-series secondary data. The data on yearly average monthly receipts and disbursement per household (All household and Worker household) (in Yen) are taken from Annual Report on the Family Income and Expenditure (Two or More Person Household) 1963-2004 published by Statistics Bureau, Ministry of Internal Affairs and Communication, Japan.

The analysis is divided into two i.e. analysis on food expenditure and analysis on living expenditure. The food expenditure covers Cereal; Fish and shellfish; Meat; Dairy products and eggs; Vegetable and seaweeds; Fruits; and Cooked food. Meanwhile, the living expenditure covers: Food; Housing; Fuel, light and water; Furniture and household utensils; Clothes and footwear; Medical care; Transportation and communication; Education; Reading and recreation; and Other living expenditure. The Other living expenditure consists of personal care, toilet articles, personal effects, tobacco, etc.

Consumer Price Indexes (CPI) on food and living expenditure (subgroup index) are taken from Annual Report on the Consumer Price Index 1963-2004 published by Statistics Bureau, Ministry of Internal Affairs and Communication, Japan. There are three year basis 1980=100; 1990=100 and 2000=100. This paper converts the index into the same base year 2000=100 (base year shifting). Prices of commodities on food and living expenditure are taken from Annual Report on the Price Survey 2000 published by Statistics Bureau, Ministry of Internal Affairs and Communication, Japan. Food commodity prices (Cereal; Fish and shellfish; Meat; Dairy products and eggs; Vegetable and seaweeds; Fruits; and Cooked food) are then derived from the simple average of two extreme prices of the items in 49 towns and villages in Japan. Prices of living expenditure (Food, Housing, Fuel, light and water, Furniture and household utensils, Clothes and footwear, Medical care, Transportation and communication, Education, Reading and recreation, and Other living expenditure) are derived from the weighted average of the items in 49 towns and villages in Japan. This paper uses the weight from the Annual Report on the Consumer Price Index 2000. Since the prices in 2000 derived, prices in the other years can be calculated by using correspondence Consumer Price Index. Data on quantity of goods or services consumed can be derived by dividing good or services expenditure with related prices.

For the case study of Indonesia, this paper uses pooled[4] (time series and cross section, panel) secondary data about individual household's expenditure from Rural Price Statistics (*Statistik Harga Pedesaan*) and Survey of Living Cost (*Survey Biaya Hidup*) published by the Central Bureau of Statistics (*Badan Pusat Statistik*, BPS) Indonesia

[4] This paper does not take into account the variation of areas (urban and rural) and times. It is simply assumed that there are no differences within areas and times. See Gudjarati (2000) for detail explanation about panel-data models.

1980, 1981, 1984, 1987, 1990, 1993 and 1996. For the comparison proposes between Japan and Indonesia, this paper uses the same kind of food products i.e. Cereal; Fish and shellfish; Meat; Dairy products and eggs; Vegetable and seaweeds; Fruits; and Cooked food. There is no analysis of living expenditure due to the lack of availability of data on prices of living expenditures in Indonesia.

Estimation

The estimation of the Linear Expenditure System (LES) shows certain complications because, while it is linear in the variables, it is non-linear in the parameters, involving the products of α_i and x_i^o in equation systems (3) and (4). There are several approaches to estimation of the system (Intriligator, Baskin, Hsaio 1996). The first approach determines the base quantities x_i^o on the basis of extraneous information or prior judgments. The system (4) then implies that expenditure on each good in excess of base expenditure $(p_i x_i - p_i x_i^o)$ is a linear function of supernumerary income, so each of the marginal budget shares α_i can be estimated applying the usual single-equation simple linear regression methods.

The second approach reverses this procedure by determining the marginal budget shares α_i on the basis of extraneous information or prior judgments (or Engel curve studies, which estimate α_i from the relationship between expenditure and income). It then estimates the base quantities x_i^o by estimating the system in which the expenditure less the marginal budget shares times income $(p_i x_i - \alpha_i M)$ is a linear function of all prices. The total sum of squared errors -over all goods as well all observations- is then minimized by choice of the x_i^o.

The third approach is an iterative one, by using an estimate of α_i conditional on the x_i^o (as in the first approach) and the estimates of the x_i^o conditional on α_i (as in the second approach) iteratively so as to minimize the total sum of squares. The process would continue, choosing α_i based on estimate x_i^o and choosing x_i^o based on the last estimated α_i, until convergence of the sum of squares is achieved.

The fourth approach selects α_i and x_i^o simultaneously by setting up a grid of possible values for the 2n-1 parameters (the –1 based on the fact that the α_i sum tends to unity, $\sum_{i=1}^{n} \alpha_i = 1$) and obtaining that point on the grid where the total sum of squares over all goods and all observations is minimized.

This paper applies the fourth approach. The reason is that when estimating a system of seemingly unrelated regression (SUR) equation, the estimation may be iterated. In this case, the initial estimation is done to estimate variance. A new set of residuals is generated and used to estimate a new variance-covariance matrix. The matrix is then used to compute a new set of parameter estimator. The iteration proceeds until the parameters converge or until the maximum number of iteration is reached. When the random errors follow a multivariate normal distribution these estimators will be the maximum likelihood estimators (Judge et al 1982:324).

Rewriting equation (4) to accommodate a sample t=1,2,3,…..T and 10 goods, for example, yields the following econometric non-linear system:

$$p_{1t}x_{1t} = p_{1t}x^{o}_{1t} + \alpha_1\left(M - \sum_{j=1}^{10} p_j x^{o}_j\right) + e_{1t}$$

$$p_{2t}x_{2t} = p_{2t}x^{o}_{2t} + \alpha_2\left(M - \sum_{j=1}^{10} p_j x^{o}_j\right) + e_{2t} \qquad \text{for all i and j} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(11)$$

....

....

$$p_{10t}x_{10t} = p_{10t}x^{o}_{10t} + \alpha_{10}\left(M - \sum_{j=1}^{10} p_j x^{o}_j\right) + e_{10t}$$

Where: e_{it} is error term equation (good) i at time t.

Given that the covariance matrix $E[e_t e_t'] = \xi$ where $e_t' = (e_{1t}, e_{2t}, \ldots\ldots\ldots\ldots e_{10t})$ and ξ is not diagonal matrix, this system can be viewed as a set of non-linear seemingly unrelated regression (SUR) equations. There is an added complication, however. Because $\sum_{i=1}^{10} p_{it} x_{it} = M$ the sum of the dependent variables is equal to one of the explanatory variables for all t, it can be shown that $(e_{1t} + e_{2t} + \ldots\ldots\ldots\ldots + e_{10t}) = 0$ and hence ξ is singular, leading to a breakdown in both estimation procedures. The problem is overcome by estimating only 9 of the ten equations, say the first nine, and using the constraint that $\sum_{i=1}^{10} \alpha_i = 1$, to obtain an estimate of the remaining coefficient α_{10} (Barten, 1977).

The first nine equations were estimated using the data and the maximum likelihood estimation procedure. The nature of the model provides some guide as to what might be good starting values for an iterative algorithm[5]. Since the constraint that the minimum observation of expenditure on good i at time t (x_{it}) is greater than the minimum expenditure x^{o}_{i} should be satisfied, the minimum x_{it} observation seems a reasonable starting value for x^{o}_{i} in iteration process. Also the average budget share, $T^{-1}\sum_{t=1}^{T}\left(p_{it}x_{it} / M_t\right)$, is likely to be a good starting value for α_i in the iterating process (Griffith et al, 1982). It is

[5] For a detailed explanation about iterative algorithms, see Griffith *et al* 1982.

because the estimates of the budget share α_i will not much differ from the average budget share.

4. RESEARCH FINDINGS

Food Consumption: 'Meat Lover' and 'Fish Lover'

The individual household tries to determine the optimal level of each goods consumed. The optimal level of goods theoretically depends on prices of goods and income, *ceteris paribus.* Other factors such as prices of substitution and complementary goods, demographic characteristics, taste, number of consumers and producers in market, special circumstances, preferences and so on are assumed to remain unchanged. Under construction of the LES, it is assumed that demand for a specific good is determined by its price, other good s' prices and income.

Table 1 exhibits the estimated parameters of equations in the LES model (equation 11) for foods in the case of Indonesia and Japan. There are two categories of households in Japan i.e. "All household and Worker household"[6]. All estimators for both minimum expenditure (x_i^o) and marginal budget share (α_i) have positive sign. Those fulfill the theoretical requirements.

[6] Mizoguchi (1995) states that the 1959 *National Survey of Family Income and Expenditure (Zenkoku Shohi Jittai Chosa),* NISFIE, was the first effort to capture household expenditure in rural area because the *Family Income and Expenditure Survey (Kakei Chosa),* FIES, was restricted to the urban area before 1962. As in the FIES, forestry, farming and fishery households were not included in the NSFIE sample frame but were included after the 1984 survey. Therefore, the recent NISFIE covers nearly all households in Japan in the population frame.

Table 1. Estimator of Parameter in the LES Model for Indonesia and Japan: Food

Food Items	Indonesia (annually)		Japan (monthly)			
			All Household		Worker Household	
	Minimum Consumption, (x_i^o)	Marginal Budget Share, (α_i)	Minimum Consumption, (x_i^o)	Marginal Budget Share, (α_i)	Minimum Consumption, (x_i^o)	Marginal Budget Share, (α_i)
Cereal	3960.684*	0.038*	0.676*	0.243*	0.869*	0.218*
Fish and shellfish	1730.131*	0.293*	10.238*	0.256*	8.734*	0.271*
Meat	550.260*	0.376*	8.832*	0.192*	13.046*	0.162*
Dairy product & eggs	565.695*	0.044*	1.529*	0.003	1.563*	0.005
Vegetable & seaweeds	1231.284*	0.111*	5.131*	0.156*	4.762*	0.172*
Fruits	636.394*	0.030*	1.242*	0.107*	0.717*	0.122*
Cooked food	1059.068*	0.107*	3.184*	0.043*	3.156*	0.049*
Maximum		**0.030**		**0.003**		**0.005**
Minimum		**0.376**		**0.256**		**0.271**

Source: see section 3, *author's calculation*

Note: * significant at level of significance 1%; ** significant at level of significance 5%; *** significant at level of significance 10%. Detail statistics are in the Appendix.

Two properties of LES are that inferior and complementary goods are disallowed. Evaluation of the expression $\frac{\partial x_i}{\partial M} = \frac{\alpha_i}{p_i}$ reveals that, in the LES, the income elasticity is always positive, inferior goods are not allowed. Cross substitution matrix are positive with LES. However, at the high level of aggregation employed in a research, this limitation is not restrictive. It would be possible to find the negative α_i, when a research is related with the aggregation data. In fact, the goods could be normal or inferior good. Therefore, when we aggregate those goods, the nature of the goods (normal or inferior) will appear in the aggregate data. The higher level of aggregation, the less likely it is that consumption of any given category would decline with an increase in income, negative α_i (Howe 1974:18).

The positive α_i means that when there is an increase in income such that supernumerary income may increase $\left(M - \sum_{j=1}^{10} p_j x_j^0\right)$ the demand for good i will also increase (normal goods). The value of α_i indicates the share of additional expenditure going to good i. In the case of Indonesia, if there is an increase in supernumerary income, the biggest proportion of it will go to meat expenditure and the smallest proportion of it will go to fruit expenditure, i.e. 37.6 percent and 3 percent, respectively. Indonesian households can be referred as 'meat lover' households. In contrast, Japanese households (both all households and Worker households), the highest marginal budget share is for Fish and shellfish and the minimum one is for Dairy product and eggs i.e. 27.1 percent and 0.5 percent, respectively. Japanese households could be called as 'fish lover' households. If there is increase in supernumerary income, 27.1 percent of it will be allocated for fish and shellfish expenditure.

The minimum consumption (x_i^o) of both Indonesian and Japanese cases are not comparable because the data (quantity and value) used are different from each other in terms of currency, prices and unit of measurements. To make it comparable, this paper constructs the ratio between minimum consumption (x_i^o) and average consumption (AC), in notation: $CR = \frac{x_i^o}{AC}$. The minimum consumption (x_i^o) can be defined as the amount of goods consumed by the 'poorest household'[7], meanwhile the average consumption (AC) can be interpreted as the amount of goods consumed by the 'average household'.

The ratio can be seen as an indicator of 'gap' between the minimum and the average expenditures (or 'gap' between the 'poorest household' and the 'average household' consumption). The ratio will lie between zero and one. The ratio CR will be close to one when the minimum consumption x_i^o is close to the average. There is no

[7] By construction of LES, a poorest household is the household which consume in the minimum amount of goods (subsistence level, x_i^o).

much difference between the minimum consumption and the average consumption. In contrast, the ratio CR will be close to zero when the minimum consumption x_i^o is far from to the average. It is theoretically hoped, the households in developed countries which have a high level on non-food consumption, will have relatively lower CR ratio than the households in developing countries which still have problems in food fulfillment. Households in developed countries have a larger variety of food consumption than household in developing countries. Japanese consumers are increasingly looking for diversity and high quality food choices (Agriculture and Agri-Food Canada 2005).

Table 2 exhibits the CR ratio for Indonesian and Japanese households. In general it is clearly shown that for all products except Dairy product and eggs, Indonesia has higher CR ratios than Japan has. This indicates that in the case of Indonesia the minimum consumption of foods are close to the average food consumptions. This finding is parallel with theory. Household in Japan which is a developed country has lower CR ratio and household in Indonesia which is a developing countries has higher CR ratio.

In the case of Indonesia, the minimum CR ratio is 0.687 (meat) and the maximum ratio is 0.992 (cereal). Although it is statistically insignificant[8], there might be negative

[8] There are indications of negative correlations between marginal budget share and the CR ratio. Here, the correlations between marginal budget share and the CR ratio are:

- Indonesia Households:

		Marginal Budget Share	CR Ratio
Marginal Budget Share	Pearson Correlation	1	-.303
	Sig. (2-tailed)	.	.510
CR Ratio	Pearson Correlation	-.303	1
	Sig. (2-tailed)	.510	.

- Japan: All Households

		Marginal Budget Share	CR Ratio
Marginal Budget Share	Pearson Correlation	1	-.672
	Sig. (2-tailed)	.	.098
CR Ratio	Pearson Correlation	-.672	1
	Sig. (2-tailed)	.098	.

- Japan: Worker Households

		Marginal Budget Share	CR Ratio
Marginal Budget Share	Pearson Correlation	1	-.592
	Sig. (2-tailed)	.	.161
CR Ratio	Pearson Correlation	-.592	1
	Sig. (2-tailed)	.161	.

correlation between CR ratio and the marginal budget share. A specific food with lower CR ratio (household minimum expenditure is close to the average) will have higher marginal budget share. For example Meat has the lowest CR ratio but has the biggest marginal budget share in the case of Indonesia. In contrast, households can relatively have access on a specific food (shown by higher the CR ratio), then the marginal budget share of it will be low. Cereal which can be gotten relatively by households (shown by high CR ratio) has relatively low marginal budget share (0.038). In the case of Japanese both All and Worker Households, Dairy product and eggs has the highest CR ratio i.e. 0.987 and 0.98 respectively. There is no much difference between the minimum and the average on it. In contrast, Fruits has the lowest CR ratio i.e. 0.21 for All households and 0.126 for the Worker household.

Table 2. Minimum, Average and Ratio

Foods	Indonesia			Japan					
				All Household			Worker Household		
	Minimum Consumption, (x_i^o)	Average Consumption (AC)	Ratio CR Minimum/Average (x_i^o/AC)	Minimum Consumption, (x_i^o)	Average Consumption (AC)	Ratio CR Minimum/Average (x_i^o/AC)	Minimum Consumption, (x_i^o)	Average Consumption (AC)	Ratio CR Minimum/Average (x_i^o/AC)
Cereal	3960.684	3993.837	0.992	0.676	2.012	0.336	0.869	1.976	0.440
Fish and shellfish	1730.131	1851.107	0.935	10.238	33.800	0.303	8.734	31.345	0.279
Meat	550.260	801.360	0.687	8.832	25.074	0.352	13.046	25.063	0.521
Dairy product & eggs	565.695	759.083	0.745	1.529	1.550	0.987	1.563	1.595	0.980
Vegetable & seaweeds	1231.284	1366.513	0.901	5.131	9.590	0.535	4.762	9.244	0.515
Fruits	636.394	764.483	0.832	1.242	5.917	0.210	0.717	5.675	0.126
Cooked food	1059.068	1345.090	0.787	3.184	6.733	0.473	3.156	6.777	0.466
Maximum			**0.687**			**0.210**			**0.126**
Minimum			**0.992**			**0.987**			**0.980**

Source: see section 3, *author's calculation*

There are some factors affecting differences in the food consumption between Indonesia and Japan such as policy and regulation (availability, safety and quality), culture, demographic and socio-economic characteristics. The availability and diversity of foods in domestic market are affected by government policy and regulation especially on agriculture sector. Indonesia has relatively loose policies and regulations on agricultural sector, especially on food, when compared with Japan. Some policies implemented by the Government of Indonesia are not in the benefit of domestic farmers. They are abolishment of fertilizer subsidy, decreasing of budget for agricultural sector and maintaining import practices of low quality rice without illegal or legal tariffs (Arfian and Wijanarko 2000).

Japan has very advanced policies and regulations on agricultural sector, especially on foods, if it can not be said 'very restricted'. The *Basic Law on Food, Agriculture and Rural Area* maintains to give the agricultural framework and policy direction of Japan. Although trade liberalization has been made somehow in Japan, significant distortions still exist in the field of both tariff and non tariff barriers such as import prohibitions, import licensing and quantitative restriction. Dairy products, vegetables, roots and tubers, products of the milling industry, sugar and sugar product have relatively high tariff protection (Agriculture and Agri-Food Canada 2005). Non ad-valorem duties are applied to live animal and products, vegetables, fats and oils, and prepared food. Tariff quotas are implemented to Dairy products, rice, wheat, barley, prepared edible fat and starches. Imports quota of rice, wheat, barley, certain milk products and silk are covered substantially by state-trading entities. A new Japanese Agriculture Standard (JAS) guarantees the traceability of imported beef and beef products not covered by the new

Beef Traceability Law. The ministry of Agriculture, Fisheries and Food (MAFF) is establishing a new JAS for pork and considering similar standards for vegetables, rice and other agricultural products. The *Food Sanitation Law* established specifications and standards for genetically modified foods, and prohibited their import unless approved under the law.

Safety and quality requirements are different between Indonesia and Japan. Indonesia has institutions related to consumers -such as National Consumer Protection Institution (*Badan Perlindungan Konsumen Nasional,* BPKN), Indonesian Consumer Institution Foundation (*Yayasan Lembaga Konsumen Indonesia,* YLKI), National Consumer Protection Institution Foundation (*Yayasan Lembaga Perlindungan Konsumen Nasional,* YLPKN), Indonesian Consumer Advocating Institution (*Lembaga Advokasi Konsumen Indonesia*, LAKI), etc- but they are relatively powerless in intervening policy or regulation related to consumers. Law No. 8/1999 about Consumer Protection was established. Nevertheless, the implementation is still far from perfect. A consumer co-cooperative is a valuable lesson from Japanese case. The Japanese movement of co-cooperatives goes back to the 19^{th} century when the first consumer cooperative was established in 1896. Today, the Japanese consumer co-operatives have established themselves as a major force in the retailing industry. Foods are the dominant products for them. The Japanese Consumers' Co-operative Union (JCCU) develops its own food standards, much stricter than those imposed by the government and ensures that food and co-op brand products supplied by their members meet its own standards for safety and quality (JCCU 2002-2003). The revision of the *Food Sanitation Law* and the passage of the new *Basic Law for Food Safety* in 2003 gave consumer co-operatives a central role in food safety (JCCU, 2002-2003). In the past (*New Order regime*), Indonesia had many kinds of co-operatives including consumer co-cooperative. But they did not develop well because the government used them as ‘political commodity’.

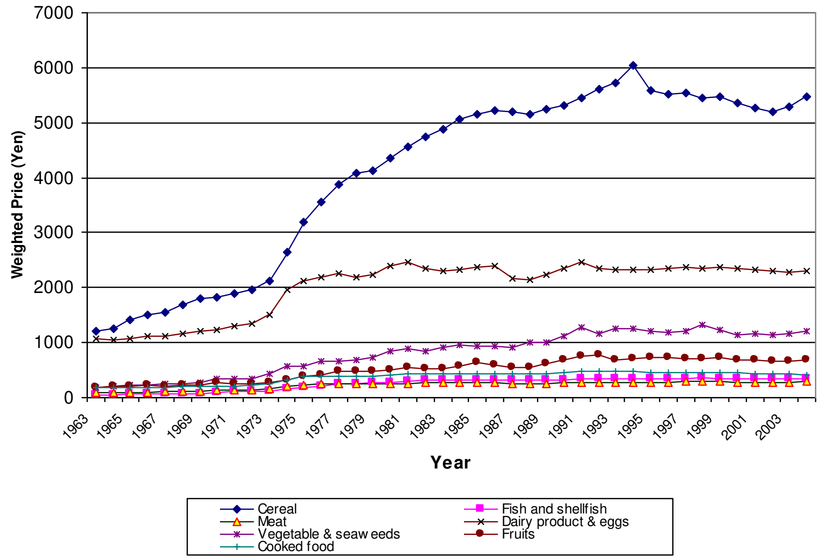
Religions, geography, climate and cultural belief, basic nutritional requirements and the unaccountable elements of tastes and preferences might affect the development of a particular country’s eating habits and cuisine. In the Japanese case, it might be easily guessed that fish and seafood – both fresh and preserved- play an important dietary role in daily life. Generally speaking, Japanese are supposed to enjoy meals with their eyes. ‘Nature’ and ‘harmony’ are words used to represent Japanese food, which is served in a very artistic and three-dimensional way. With preference put on freshness and natural flavor, Japanese people love foods and ingredients that are at their ‘shun’ （now-in-season）. They believe that eating the ingredients that are at their ‘shun’ will be good both for the health and spiritual life.

The Japanese food culture is also influenced by religious beliefs. Despite much longer existence of Shinto and Confucianism, Buddhism became the official religion of Japan in the sixth century. During the following 1,200 years, meat was a prohibited food to the Japanese because Buddhist teaching did not allow killing of animals for food. Meat was allowed for sale and consumption only after the Meiji Restoration in 1867. Although meat is widely consumed, only certain cuts are preferred (Agriculture and Agri-Food Canada 2005). In contrast, Islam (Moslem) religion is the dominant religion in Indonesia. Indonesia is the biggest Moslem country in the world. At least, there are two big religion days of Islam i.e. *Idul Fitri* and *Idul Adha*. In the *Idul Adha*, Moslem people cut sheep and cow for the sacrificing. *Idul Fitri* is the day for celebrating the end of the fasting time, holy Ramadan. In the *Idul Fitri,* Indonesian Moslem households always serve delicious foods in which the ingredient is meat.

Food Consumption: Welfare Change

In the developed countries like Japan, it is common that prices are relatively stable. Figure 3 exhibits the fact that there was only small upward tendencies of foods except Cereal during period 1963-2004 in Japan. There was a sharp increase of Cereal in 1974-1987, but after its fluctuation become flattered in a certain level. There has been change in food consumption (Agriculture and Agri-Food Canada 2005). Due to rapid economic growth in the 1960s and 1970s, the traditional way of eating reliant on rice and fish, gradually shifted towards new food products such as livestock and dairy products. The mid 1980s saw the emergence of a variety of processed foods and the proliferation of fast food restaurants. In 1990s, there were change in dining pattern from the traditional form of dining at home at a fixed time with all household members present to ‘flexible meal pattern’ with family members having own meals at different times to suit their lifestyles and schedules. These development leads to a strong preference for processed foods and eating out.

Figure 3. Price of Foods, (1963-2004)



Source: see section 3, *author's calculation*

Table 3 represents the annual average growths of prices and quantities demanded by both All household and Worker household 1963-2004. The food with highest annual average growth of price was Fish and shellfish (5.16%). It was followed by Vegetable and seaweeds (5.07%), Cereal (3.87%), Fruits (3.40%), Meat (3.21%), Cooked food (2.17%) and finally Dairy product and eggs (2.05%). There were negative growth of quantity demanded for All household and Worker household for Cereal (-2.13% and -2%, respectively), Fish and shellfish (-1.51% and -1.53, respectively), vegetable and seaweeds (-0.89% and -1.92%, respectively) and Fruits (-0.14% and -0.39% respectively). In contrast, there were positive annual growth of quantity demanded for All household and Worker Household for Meat (0.75% and 0.47% respectively), Dairy product and eggs (0.47%) and Cooked food (0.66% and 0.71% respectively). It implies that there were decrease in quantity demanded for Cereal, Fish and shellfish, Vegetable and seaweeds, and fruits and increases quantity demanded on Meat, Dairy product of eggs and cooked food for 1963-2004.

Table 3 Annual Average Growths of Food Prices and Quantity Demanded (in percent/year), 1963-2004

Foods	Increase of Price	Growth of Quantity Demanded	
		All Household	Worker Household
Cereal	3.89	-2.13	-2.00
Fish and shellfish	5.16	-1.51	-1.53
Meat	3.21	0.75	1.00
Dairy product & eggs	2.05	0.47	0.47
Vegetable & seaweeds	5.07	-0.89	-0.92
Fruits	3.40	-0.14	-0.39
Cooked food	2.17	0.66	0.71

Source: see section 3, *author's calculation*

The increase of prices will be used to make a simulation of welfare changes. We also use the similar increase of prices in the case of Indonesia for comparison proposes. As previously described in part 3, if there were changes in prices there might be changes of households' welfare measured by Compensating Variation (CV) and Equivalent Variation (EV).

Table 4. Individual Household's Welfare Change of Food Consumption (per month)

Welfare Change Measurement	Indonesia	Japan	
		All Household	Worker Household
Equivalent Variation (EV) - In currency (per year) - In percentage of total expenditure (%)	- Rp 3,728.08 (≈-¥ 46.60*) (-0.341)	- ¥ 128.29 (-0.334)	- ¥122.06 (-0.330)
Compensating Variation (CV) - In national currency (per year) - In percentage of total expenditure (%)	-Rp 3,740.07 (≈ -¥46.75*) (-0.342)	- ¥ 128.73 (-0.335)	- ¥ 122.48 (-0.331)

Source: see section 3, *author's calculation*
Note: * exchange rate ¥1=Rp 80 (Rp is Indonesian currency, Rupiah)

Table 4 represents the CV and EV. The price changes of foods have caused a decrease of households' welfare. The welfare decrease of Japanese households is almost three times that of the Indonesian households' household. The Indonesian households' welfare measured by EV and CV are Rp 3,728 and Rp 3,740 which is equal to ¥ 46.60

and ¥ 46.75 at the exchange rate ¥1=Rp 80, respectively. At the same price changes, Japanese households undergo welfare decrease measured by EV and CV ; i.e. ¥ 128.28 and ¥ 128.73 for All Household and ¥ 122.06 and ¥ 122.48 for Worker Household, respectively. Although Japanese households get greater welfare decrease in absolute amount, in relative term to total food expenditure Indonesian households have greater welfare decrease.

Living Expenditure

This part describes the estimation of the LES for the broader group of expenditure than food expenditure previously analyzed i.e. living expenditure in the case of Japan. We do not analyze Indonesian case because there is no data on prices of living expenditure. The living expenditure consists of Food; Housing; Fuel, light and water charges; Furniture and household utensils; Clothes and Footwear; Medical care; Transportation and communication; Education; Reading and recreation; and Other living expenditure. The Other living expenditure consists of personal care services, toilet articles, personal effects, tobacco, etc.

Table 5 exhibits the estimated parameters of equations in LES model (equation 14) for living expenditure items in the case of the Japanese household, both All household and Worker household. The minimum consumption (x_i^o) of specific expenditure is a minimum quantity of the packet of goods/services in the specific category consumed by individual household in a month. Therefore, if we want to know the minimum expenditure for a specific item we just need to multiply this figure with its corresponding general price ($p_i x_i^o$)[9].

Table 5. Estimator of Parameter in the LES Model for Japan: Living Expenditures (Monthly)

Living Expenditure Items	All Household		Worker Household	
	Minimum Consumption, (x_i^o)	Marginal Budget Share, (α_i)	Minimum Consumption, (x_i^o)	Marginal Budget Share, (α_i)
Food	45.95*	0.04**	30.13*	0.16*
Housing	1.58*	0.06*	2.13*	0.03*
Fuel, Light & Water Charges	4.22*	0.06*	4.41*	0.03*
Furniture & Household Utensils	3.00*	0.04*	2.23*	0.04*
Clothes and Footwear	20.27*	0.01	3.34***	0.09*
Medical care	6.50*	0.04*	8.37*	0.02*
Transportation and Communication	5.66*	0.18*	15.22*	0.07*
Education	23.00*	0.06*	23.65*	0.05*
Reading and Recreation	11.49*	0.13*	13.13*	0.08*
Other living expenditure	14.15*	0.39*	1.89*	0.43
Maximum		**0.39**		**0.43**
Minimum		**0.01**		**0.02**

Source: see section 3, *author calculation*
Note: * significant at level of significance 1%
** significant at level of significance 5%
*** significant at level of significance 10%
Detail statistics are in the Appendix

All estimators both minimum consumptions (x_1^o) and marginal budget share (α_i) have positive sign. Those fulfill the theoretical requirements. All estimators are significant less than 1% level of significance except minimum consumption of Clothes and footwear in the case of Worker household which is significant at 10% level of significance. In addition, the marginal budget share of Clothes and footwear in the case of All household and the marginal budget share of Other living expenditure are statistically

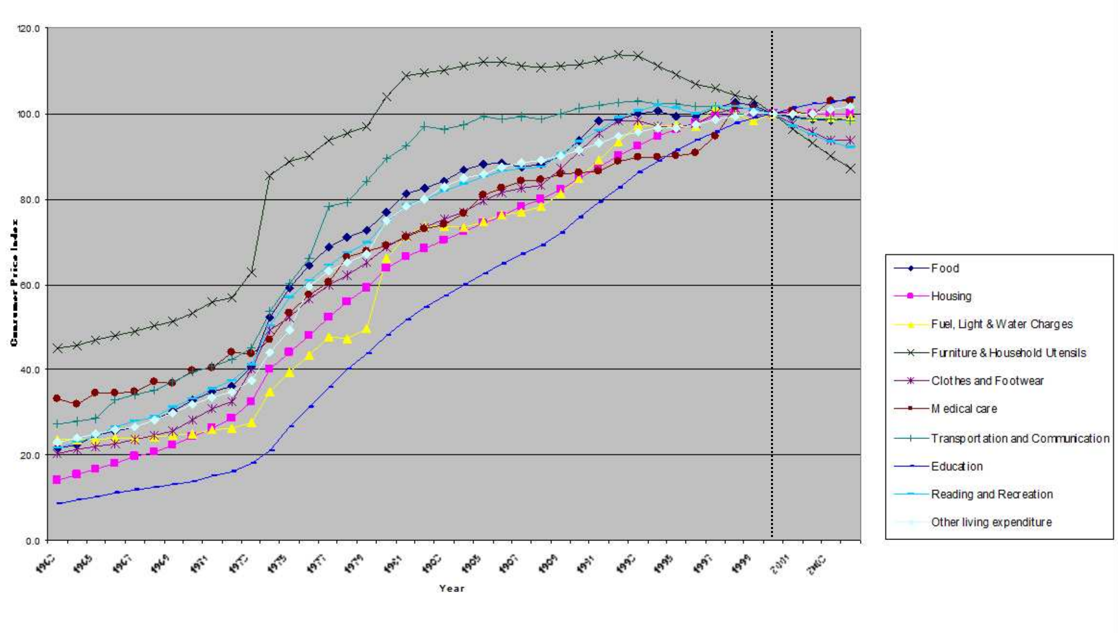
[9] Minimum expenditure of living expenditure item i can be calculated by using formula $p_i x_i^o$. The sum up of the minimum expenditure (i) refers to the poor household's expenditure which can be used as measurement of poverty line. Poverty line under LES is $\sum_i p_i x_i^o$

insignificant. The last two rows of Table 5 represent maximum and minimum values of marginal budget share of the All household and the Worker household. The maximum marginal budget share is for the other living expenditure, i.e 0.39 for the All household and 0.43 for the Worker household. It means that if there is an additional supernumerary income, the expenditure on the other living expenditure will get highest proportion.

Welfare Change Simulation: Japan 2000-2004

Figure 4 exhibits Consumer Price Index (CPI) for Living Expenditure Group: Food; Housing; Fuel, light and water charges; Furniture and household utensils; Clothes and footwear; Medical care; Transportation and communication; Education; Reading and recreation; and Other living expenditure. It is interesting to analyse the change in CPI for living expenditure group especially 'before' and 'after' 2000. Furniture and household utensil had the highest index before 2000 and it becomes the lowest after 2000. The index of Furniture and household has downward tendency since 1993. In contrast, Education had lowest index before 2000 and it becomes the highest after 2000. The index of Eduction has upward tendency.

Figure 4. Consumer Price Index: Living Expenditure Group, 1963-2004 (2000=100)



Source: SBMIAC-Japan, Annual Report on the Consumer Price Index 1963-2004. Note: Author conducts the base year shifting from 1980=100 and 1990=100 into 2000=100.

For the last four year period (2001-2004) compared to 2000, there were price changes in living expenditure. There was deflation in Furniture and household utensils; Reading and recreation; Clothes and footwear; Transportation and communication; Fuel, light and water charges; and Housing. In contrast, there was inflation in Medical care; Education and Other living expenditure. The index of housing was relatively stable.

Table 6. Price Change of Living Expenditure

Items	Year			
	2000-2001	2001-2002	2002-2003	2003-2004
Food	-0.60	-0.80	-0.20	0.91
Housing	0.20	-0.10	-0.10	-0.20
Fuel, Light & Water Charges	0.60	-1.19	-0.50	0.10
Furniture & Household Utensils	-3.60	-3.63	-3.01	-3.33
Clothes and Footwear	-2.20	-2.25	-1.88	-0.21
Medical care	0.70	-1.19	3.42	0.00
Transportation and Communication	-0.90	-0.61	0.10	-0.20
Education	1.10	0.99	0.59	0.68
Reading and Recreation	-3.00	-2.16	-1.48	-1.39
Other living expenditure	-0.20	0.20	0.90	0.59

Source: see section 3, *author's calculation*

Table 6 represents the average annual price changes. We use these price changes to simulate the welfare impact. Table 7 represents the welfare impact of price change in 2000-2001 based on the price changes represented in Table 6 and under the assumption of no-change in income. The price changes during the period 2000-2004 increased welfare measured by EV and CV, ¥ 4,548 and ¥ 4,519 respectively for All Household; and ¥ 4,774 and ¥ 4,739 respectively for Worker Household.

Table 7. Welfare Effect of Prices Change: 2000-2004 (in ¥ per year)

Period	Household	Equivalent Variation (EV)	Compensating Variation (CV)
200-2001	All Household	2,319	2,303
	Worker Household	2,459	2,440
2001-2002	All Household	2,425	2,411
	Worker Household	2,516	2,500
2002-2003	All Household	247	248
	Worker Household	226	226
2003-3004	All Household	-443	-443
	Worker Household	-426	-427
2000-2004	All Household	4,548	4,519
	Worker Household	4,774	4,739

Source: see section 3, *author calculation*

5. Conclusions

This paper uses Linear Expenditure System (LES) in deriving demand and welfare measurement. Seemingly Uncorrelated Regression (SUR) is applied to estimate the demand. Some conclusions are withdrawn. *First,* Indonesian households have the maximum marginal budget share on Meat and the minimum one on Fruits; meanwhile Japanese households have the maximum marginal budget share on Fish and shellfish and the minimum one on Dairy product and eggs. Indonesian households are 'meat lover' and Japanese households are 'fish lover'. *Second*, Indonesian households have smaller gaps between minimum consumptions (subsistence level) and average consumptions than Japanese household have. *Third*, with the same level of price increase on foods, in nominal-term (Yen, ¥) Japanese households undergo greater welfare decrease than Indonesian households do. In the percentage of total food expenditure, Indonesian households undergo greater welfare decrease than Japanese households get. *Fourth,* for the period 2000-2004 the price changes in living expenditure increased welfare for both All Household and Worker Household.

For future study, a research might consider number of family member (household size) for example one-person and two or more person household. In the literature, it is called demographic equivalent scale. This can show us the marginal living cost of the one additional household's member. Another research can be also conducted for several different groups of household for example: income group, location (districts, rural-urban), etc.

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Appendix: Estimation of LES model: Food (Indonesia)

Estimation Method: Iterative Seemingly Unrelated Regression (Marquardt)
Sample: 1 300
Simultaneous weighting matrix & coefficient iteration
Convergence achieved after: 7 weight matrices, 8 total coef iterations

	Coefficient	Std. Error	t-Statistic	Prob.
C(2)	1730.131	96.80288	17.87272	0.0000
C(9)	0.292974	0.011889	24.64156	0.0000
C(1)	3960.684	101.2355	39.12347	0.0000
C(3)	550.2596	53.27179	10.32929	0.0000
C(4)	565.6951	51.96354	10.88639	0.0000
C(5)	1231.284	47.68557	25.82090	0.0000
C(6)	636.3937	34.52336	18.43372	0.0000
C(7)	1059.068	116.3083	9.105701	0.0000
C(10)	0.375768	0.011298	33.26098	0.0000
C(11)	0.044370	0.001045	42.43871	0.0000
C(12)	0.111490	0.003220	34.62540	0.0000
C(13)	0.030122	0.000950	31.69453	0.0000
C(14)	0.107333	0.003646	29.43464	0.0000

Determinant residual covariance 4.93E+66

Equation: Q2*P2=C(2)*P2+C(9)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5*C(5)-P6*C(6)-P7*C(7))
Observations: 300

R-squared	0.861994	Mean dependent var	4354403.
Adjusted R-squared	0.858686	S.D. dependent var	4591288.
S.E. of regression	1725946.	Sum squared resid	8.70E+14
Durbin-Watson stat	0.959482		

Equation: Q3*P3=C(3)*P3+C(10)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5*C(5)-P6*C(6)-P7*C(7))
Observations: 300

R-squared	0.886532	Mean dependent var	3772903.
Adjusted R-squared	0.883812	S.D. dependent var	4740444.
S.E. of regression	1615846.	Sum squared resid	7.62E+14
Durbin-Watson stat	1.081532		

Equation: Q4*P4=C(4)*P4+C(11)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5*C(5)-P6*C(6)-P7*C(7))
Observations: 300

R-squared	0.936186	Mean dependent var	408288.8
Adjusted R-squared	0.934657	S.D. dependent var	561383.9
S.E. of regression	143503.0	Sum squared resid	6.01E+12
Durbin-Watson stat	1.033030		

Equation: Q5*P5=C(5)*P5+C(12)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5*C(5)-P6*C(6)-P7*C(7))
Observations: 300

R-squared	0.931772	Mean dependent var	1802176.
Adjusted R-squared	0.930137	S.D. dependent var	1766393.
S.E. of regression	466886.7	Sum squared resid	6.37E+13
Durbin-Watson stat	1.217527		

Equation: Q6*P6=C(6)*P6+C(13)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5*C(5)-P6*C(6)-P7*C(7))
Observations: 300

R-squared	0.892112	Mean dependent var	395425.4
Adjusted R-squared	0.889525	S.D. dependent var	419288.6
S.E. of regression	139362.1	Sum squared resid	5.67E+12
Durbin-Watson stat	1.143906		

Equation: Q7*P7=C(7)*P6+C(14)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5*C(5)-P6*C(6)-P7*C(7))
Observations: 300

R-squared	0.831429	Mean dependent var	937859.6
Adjusted R-squared	0.827388	S.D. dependent var	1304308.
S.E. of regression	541895.1	Sum squared resid	8.57E+13
Durbin-Watson stat	1.157530		

Appendix: Estimation of LES model: Food (Japan: All Household)

System: ALLHOUSEHOLDFOOD7GOODS
Estimation Method: Iterative Seemingly Unrelated Regression (Marquardt)
Sample: 1963 2004
Simultaneous weighting matrix & coefficient iteration
Convergence achieved after: 30 weight matrices, 31 total coef iterations

	Coefficient	Std. Error	t-Statistic	Prob.
C(2)	10.23776	1.077462	9.501740	0.0000
C(9)	0.255522	0.007457	34.26457	0.0000
C(1)	0.676021	0.145637	4.641832	0.0000
C(3)	8.832328	1.379303	6.403472	0.0000
C(4)	1.529488	0.066797	22.89768	0.0000
C(5)	5.131347	0.169412	30.28915	0.0000
C(6)	1.242047	0.307089	4.044584	0.0001
C(7)	3.183863	0.223640	14.23658	0.0000
C(10)	0.191931	0.012874	14.90898	0.0000
C(11)	0.003197	0.006366	0.502184	0.6160
C(12)	0.156375	0.003931	39.78364	0.0000
C(13)	0.107321	0.004795	22.38187	0.0000
C(14)	0.043132	0.004647	9.280922	0.0000

Determinant residual covariance 2.80E+26

Equation: Q2*P2=C(2)*P2+C(9)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5*C(5)-P6*C(6)-P7*C(7))
Observations: 42

R-squared	0.992949	Mean dependent var	7761.045
Adjusted R-squared	0.991498	S.D. dependent var	2995.292
S.E. of regression	276.1869	Sum squared resid	2593493.
Durbin-Watson stat	0.683571		

Equation: Q3*P3=C(3)*P3+C(10)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5*C(5)-P6*C(6)-P7*C(7))
Observations: 42

R-squared	0.972296	Mean dependent var	5854.490
Adjusted R-squared	0.966592	S.D. dependent var	2246.727
S.E. of regression	410.6512	Sum squared resid	5733569.
Durbin-Watson stat	0.082885		

Equation: Q4*P4=C(4)*P4+C(11)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5*C(5)-P6*C(6)-P7*C(7))
Observations: 42

R-squared	0.968851	Mean dependent var	3129.069
Adjusted R-squared	0.962438	S.D. dependent var	830.5084
S.E. of regression	160.9607	Sum squared resid	880884.3
Durbin-Watson stat	0.640499		

Equation: Q5*P5=C(5)*P5+C(12)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5*C(5)-P6*C(6)-P7*C(7))
Observations: 42

R-squared	0.998686	Mean dependent var	7416.419
Adjusted R-squared	0.998416	S.D. dependent var	2860.636
S.E. of regression	113.8691	Sum squared resid	440849.6
Durbin-Watson stat	1.101244		

Equation: Q6*P6=C(6)*P6+C(13)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5*C(5)-P6*C(6)-P7*C(7))
Observations: 42

R-squared	0.966330	Mean dependent var	2866.005
Adjusted R-squared	0.959398	S.D. dependent var	907.0405
S.E. of regression	182.7686	Sum squared resid	1135748.
Durbin-Watson stat	0.440875		

Equation: Q7*P7=C(7)*P6+C(14)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5*C(5)-P6*C(6)-P7*C(7))
Observations: 42

R-squared	0.952409	Mean dependent var	2525.074
Adjusted R-squared	0.942611	S.D. dependent var	810.8861
S.E. of regression	194.2565	Sum squared resid	1283011.
Durbin-Watson stat	0.368019		

Appendix: Estimation of LES model: Food (Japan: Worker Household)

Estimation Method: Iterative Seemingly Unrelated Regression (Marquardt)
Sample: 1963 2004
Simultaneous weighting matrix & coefficient iteration
Convergence achieved after: 36 weight matrices, 37 total coef iterations

	Coefficient	Std. Error	t-Statistic	Prob.
C(2)	8.733630	0.798757	10.93402	0.0000
C(9)	0.271262	0.005702	47.57661	0.0000
C(1)	0.869390	0.112168	7.750792	0.0000
C(3)	13.04640	0.935430	13.94695	0.0000
C(4)	1.562512	0.050670	30.83705	0.0000
C(5)	4.762436	0.147292	32.33336	0.0000
C(6)	0.717227	0.313160	2.290288	0.0229
C(7)	3.155576	0.273969	11.51802	0.0000
C(10)	0.161556	0.011809	13.68056	0.0000
C(11)	0.005467	0.005296	1.032283	0.3030
C(12)	0.172316	0.003446	50.00750	0.0000
C(13)	0.122392	0.005431	22.53759	0.0000
C(14)	0.049221	0.006499	7.573839	0.0000

Determinant residual covariance 2.10E+26

Equation: Q2*P2=C(2)*P2+C(9)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5
*C(5)-P6*C(6)-P7*C(7))
Observations: 42

R-squared	0.994529	Mean dependent var	7261.873
Adjusted R-squared	0.993403	S.D. dependent var	2873.907
S.E. of regression	233.4320	Sum squared resid	1852677.
Durbin-Watson stat	0.322206		

Equation: Q3*P3=C(3)*P3+C(10)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5
*C(5)-P6*C(6)-P7*C(7))
Observations: 42

R-squared	0.967785	Mean dependent var	5891.457
Adjusted R-squared	0.961152	S.D. dependent var	2313.274
S.E. of regression	455.9429	Sum squared resid	7068053.
Durbin-Watson stat	0.050822		

Equation: Q4*P4=C(4)*P4+C(11)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5
*C(5)-P6*C(6)-P7*C(7))
Observations: 42

R-squared	0.973926	Mean dependent var	3227.914
Adjusted R-squared	0.968557	S.D. dependent var	877.4583
S.E. of regression	155.5915	Sum squared resid	823096.4
Durbin-Watson stat	0.372473		

Equation: Q5*P5=C(5)*P5+C(12)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5
*C(5)-P6*C(6)-P7*C(7))
Observations: 42

R-squared	0.998672	Mean dependent var	7158.602
Adjusted R-squared	0.998399	S.D. dependent var	2778.454
S.E. of regression	111.1770	Sum squared resid	420250.9
Durbin-Watson stat	0.684805		

Equation: Q6*P6=C(6)*P6+C(13)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5
*C(5)-P6*C(6)-P7*C(7))
Observations: 42

R-squared	0.949838	Mean dependent var	2722.292
Adjusted R-squared	0.939511	S.D. dependent var	861.7822
S.E. of regression	211.9516	Sum squared resid	1527398.
Durbin-Watson stat	0.399310		

Equation: Q7*P7=C(7)*P6+C(14)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5
*C(5)-P6*C(6)-P7*C(7))
Observations: 42

R-squared	0.923765	Mean dependent var	2550.960
Adjusted R-squared	0.908069	S.D. dependent var	853.2423
S.E. of regression	258.7037	Sum squared resid	2275539.
Durbin-Watson stat	1.250834		

Appendix: Estimation of LES model: Living Expenditure (Japan: All Household)

Estimation Method: Iterative Seemingly Unrelated Regression
Sample: 1963 2004
Simultaneous weighting matrix & coefficient iteration
Convergence achieved after: 353 weight matrices, 354 total coef iterations

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	45.94734	1.144154	40.15834	0.0000
C(11)	0.038658	0.015337	2.520536	0.0121
C(2)	1.578613	0.209419	7.538062	0.0000
C(3)	4.215196	0.359267	11.73275	0.0000
C(4)	3.002279	0.157802	19.02557	0.0000
C(5)	20.26634	1.456098	13.91825	0.0000
C(6)	6.496677	0.555443	11.69639	0.0000
C(7)	5.658154	0.944276	5.992055	0.0000
C(8)	23.00385	1.942689	11.84124	0.0000
C(9)	11.48821	0.933180	12.31082	0.0000
C(10)	14.14749	1.277116	11.07768	0.0000
C(12)	0.055397	0.011332	4.888491	0.0000
C(13)	0.060448	0.008723	6.929946	0.0000
C(14)	0.043998	0.003348	13.14252	0.0000
C(15)	0.006057	0.012247	0.494564	0.6212
C(16)	0.041151	0.003533	11.64695	0.0000
C(17)	0.183153	0.014278	12.82767	0.0000
C(18)	0.056413	0.004794	11.76735	0.0000
C(19)	0.132136	0.007510	17.59351	0.0000
C(20)	0.387526	0.008338	46.47543	0.0000

Determinant residual covariance 1.11E+57

Equation: Q1*P1=C(1)*P1+C(11)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5*C(5)-P6*C(6)-P7*C(7)-P8*C(8)-P9*C(9)-P10*C(10))
Observations: 42

R-squared	0.966104	Mean dependent var	58861.86
Adjusted R-squared	0.955169	S.D. dependent var	22741.18
S.E. of regression	4815.051	Sum squared resid	7.19E+08
Durbin-Watson stat	0.038642		

Equation: Q2*P2=C(2)*P2+C(12)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5*C(5)-P6*C(6)-P7*C(7)-P8*C(8)-P9*C(9)-P10*C(10))
Observations: 42

R-squared	0.860528	Mean dependent var	11910.43
Adjusted R-squared	0.815536	S.D. dependent var	7451.764
S.E. of regression	3200.474	Sum squared resid	3.18E+08
Durbin-Watson stat	0.121035		

Equation: Q3*P3=C(3)*P3+C(13)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5*C(5)-P6*C(6)-P7*C(7)-P8*C(8)-P9*C(9)-P10*C(10))
Observations: 42

R-squared	0.968397	Mean dependent var	13246.93
Adjusted R-squared	0.958202	S.D. dependent var	7358.531
S.E. of regression	1504.414	Sum squared resid	70161070
Durbin-Watson stat	0.467150		

Equation: Q4*P4=C(4)*P4+C(14)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5*C(5)-P6*C(6)-P7*C(7)-P8*C(8)-P9*C(9)-P10*C(10))
Observations: 42

R-squared	0.966254	Mean dependent var	9093.167
Adjusted R-squared	0.955369	S.D. dependent var	3700.166
S.E. of regression	781.7009	Sum squared resid	18942747
Durbin-Watson stat	1.589041		

Equation: Q5*P5=C(5)*P5+C(15)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5*C(5)-P6*C(6)-P7*C(7)-P8*C(8)-P9*C(9)-P10*C(10))
Observations: 42

R-squared	0.710199	Mean dependent var	15297.67
Adjusted R-squared	0.616715	S.D. dependent var	5866.516
S.E. of regression	3631.959	Sum squared resid	4.09E+08
Durbin-Watson stat	0.050808		

Equation: Q6*P6=C(6)*P6+C(16)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5 *C(5)-P6*C(6)-P7*C(7)-P8*C(8)-P9*C(9)-P10*C(10))

Observations: 42

R-squared	0.899724	Mean dependent var	6557.690
Adjusted R-squared	0.867377	S.D. dependent var	3703.530
S.E. of regression	1348.732	Sum squared resid	56391449
Durbin-Watson stat	0.076537		

Equation: Q7*P7=C(7)*P7+C(17)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5 *C(5)-P6*C(6)-P7*C(7)-P8*C(8)-P9*C(9)-P10*C(10))

Observations: 42

R-squared	0.904552	Mean dependent var	20660.10
Adjusted R-squared	0.873763	S.D. dependent var	12946.04
S.E. of regression	4599.713	Sum squared resid	6.56E+08
Durbin-Watson stat	0.068291		

Equation: Q8*P8=C(8)*P8+C(18)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5 *C(5)-P6*C(6)-P7*C(7)-P8*C(8)-P9*C(9)-P10*C(10))

Observations: 42

R-squared	0.981963	Mean dependent var	9023.143
Adjusted R-squared	0.976145	S.D. dependent var	5188.639
S.E. of regression	801.3947	Sum squared resid	19909236
Durbin-Watson stat	0.390556		

Equation: Q9*P9=C(9)*P9+C(19)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5 *C(5)-P6*C(6)-P7*C(7)-P8*C(8)-P9*C(9)-P10*C(10))

Observations: 42

R-squared	0.978198	Mean dependent var	20732.33
Adjusted R-squared	0.971165	S.D. dependent var	10924.29
S.E. of regression	1855.049	Sum squared resid	1.07E+08
Durbin-Watson stat	0.151659		

Equation: Q10*P10=C(10)*P10+C(20)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4 *C(4)-P5*C(5)-P6*C(6)-P7*C(7)-P8*C(8)-P9*C(9)-P10*C(10))

Observations: 42

R-squared	0.997438	Mean dependent var	56794.12
Adjusted R-squared	0.996611	S.D. dependent var	28596.44
S.E. of regression	1664.662	Sum squared resid	85904073
Durbin-Watson stat	0.713423		

Appendix: Estimation of LES model: Living Expenditure (Japan: Worker Household)

Estimation Method: Iterative Seemingly Unrelated Regression
Sample: 1963 2004
Simultaneous weighting matrix & coefficient iteration
Convergence achieved after: 182 weight matrices, 183 total coef iterations

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	30.12914	1.443349	20.87447	0.0000
C(11)	0.159825	0.009160	17.44780	0.0000
C(2)	2.127116	0.268021	7.936365	0.0000
C(3)	4.406852	0.484444	9.096718	0.0000
C(4)	2.231857	0.149199	14.95893	0.0000
C(5)	3.338788	1.904799	1.752830	0.0804
C(6)	8.367445	0.504365	16.59005	0.0000
C(7)	15.21961	1.041232	14.61693	0.0000
C(8)	23.64671	2.465731	9.590142	0.0000
C(9)	13.12788	0.949276	13.82935	0.0000
C(10)	1.894845	1.874412	1.010901	0.3127
C(12)	0.025640	0.009217	2.782005	0.0057
C(13)	0.032139	0.006734	4.772926	0.0000
C(14)	0.039869	0.001916	20.80636	0.0000
C(15)	0.092085	0.007918	11.63033	0.0000
C(16)	0.018334	0.002016	9.093137	0.0000
C(17)	0.071557	0.010444	6.851537	0.0000
C(18)	0.049079	0.004059	12.09011	0.0000
C(19)	0.081227	0.005435	14.94490	0.0000
C(20)	0.431541	0.010056	42.91409	0.0000

Determinant residual covariance 5.43E+57

Equation: Q1*P1=C(1)*P1+C(11)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5*C(5)-P6*C(6)-P7*C(7)-P8*C(8)-P9*C(9)-P10*C(10))
Observations: 42

R-squared	0.957140	Mean dependent var	59040.74
Adjusted R-squared	0.943314	S.D. dependent var	23432.43
S.E. of regression	5578.993	Sum squared resid	9.65E+08
Durbin-Watson stat	0.028467		

Equation: Q2*P2=C(2)*P2+C(12)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5*C(5)-P6*C(6)-P7*C(7)-P8*C(8)-P9*C(9)-P10*C(10))
Observations: 42

R-squared	0.942870	Mean dependent var	13303.00
Adjusted R-squared	0.924440	S.D. dependent var	7414.442
S.E. of regression	2038.088	Sum squared resid	1.29E+08
Durbin-Watson stat	0.367242		

Equation: Q3*P3=C(3)*P3+C(13)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5*C(5)-P6*C(6)-P7*C(7)-P8*C(8)-P9*C(9)-P10*C(10))
Observations: 42

R-squared	0.956955	Mean dependent var	12759.76
Adjusted R-squared	0.943069	S.D. dependent var	7192.120
S.E. of regression	1716.049	Sum squared resid	91289531
Durbin-Watson stat	0.373301		

Equation: Q4*P4=C(4)*P4+C(14)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5*C(5)-P6*C(6)-P7*C(7)-P8*C(8)-P9*C(9)-P10*C(10))
Observations: 42

R-squared	0.968221	Mean dependent var	9529.976
Adjusted R-squared	0.957970	S.D. dependent var	3783.543
S.E. of regression	775.6717	Sum squared resid	18651662
Durbin-Watson stat	1.056354		

Equation: Q5*P5=C(5)*P5+C(15)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5*C(5)-P6*C(6)-P7*C(7)-P8*C(8)-P9*C(9)-P10*C(10))
Observations: 42

R-squared	0.682316	Mean dependent var	15840.24
Adjusted R-squared	0.579837	S.D. dependent var	6101.853
S.E. of regression	3955.219	Sum squared resid	4.85E+08

Durbin-Watson stat	0.034563		

Equation: Q6*P6=C(6)*P6+C(16)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5 *C(5)-P6*C(6)-P7*C(7)-P8*C(8)-P9*C(9)-P10*C(10))
Observations: 42

R-squared	0.922654	Mean dependent var	6389.881
Adjusted R-squared	0.897703	S.D. dependent var	3483.446
S.E. of regression	1114.141	Sum squared resid	38480640
Durbin-Watson stat	0.101254		

Equation: Q7*P7=C(7)*P7+C(17)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5 *C(5)-P6*C(6)-P7*C(7)-P8*C(8)-P9*C(9)-P10*C(10))
Observations: 42

R-squared	0.830853	Mean dependent var	23775.81
Adjusted R-squared	0.776290	S.D. dependent var	15321.30
S.E. of regression	7246.673	Sum squared resid	1.63E+09
Durbin-Watson stat	0.038749		

Equation: Q8*P8=C(8)*P8+C(18)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5 *C(5)-P6*C(6)-P7*C(7)-P8*C(8)-P9*C(9)-P10*C(10))
Observations: 42

R-squared	0.970861	Mean dependent var	10710.48
Adjusted R-squared	0.961461	S.D. dependent var	6780.964
S.E. of regression	1331.194	Sum squared resid	54934425
Durbin-Watson stat	0.155559		

Equation: Q9*P9=C(9)*P9+C(19)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4*C(4)-P5 *C(5)-P6*C(6)-P7*C(7)-P8*C(8)-P9*C(9)-P10*C(10))
Observations: 42

R-squared	0.975174	Mean dependent var	21680.40
Adjusted R-squared	0.967165	S.D. dependent var	11439.73
S.E. of regression	2072.920	Sum squared resid	1.33E+08
Durbin-Watson stat	0.113169		

Equation: Q10*P10=C(10)*P10+C(20)*(M-P1*C(1)-P2*C(2)-P3*C(3)-P4 *C(4)-P5*C(5)-P6*C(6)-P7*C(7)-P8*C(8)-P9*C(9)-P10*C(10))
Observations: 42

R-squared	0.988240	Mean dependent var	62163.55
Adjusted R-squared	0.984446	S.D. dependent var	31083.41
S.E. of regression	3876.528	Sum squared resid	4.66E+08
Durbin-Watson stat	0.140695		