THE SOCIOECONOMIC VARIABLES AND FOOD CONSUMPTION EXPENDITURE: AN ANALYSIS OF TAIWAN'S FAMILY INCOME AND EXPENDITURE SURVEY DATA IN 1992*

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This study uses the Barten household size effect model as the key fundation to explore the hedonic prices of staple food, meat, fish/shell, vegetable, and fruit, in the cross-section data. The linar approximation almost ideal demand system incorporating socioecnonomic variables is furthermore employed for estimation.

Results of this study indicate that the Marshallian own price elasticities and Hicks own price elasticities are in between -0.24 ~ -0.33 and -0.28 ~ -0.55, respectively. All five food products are gross complement and net substitute. The proposed socioeconomic variables and the individual food item are also verified to have different relatonship and impactation.

Key Words: The survey of family income and expenditure, Barten household size effect model, Linear approximation almost ideal demand system.

I. Introduction

1. Study Purpose:

Using cross-section data for demand analysis, there are at least two merits: first, is to provide a larger sample observed; second, is to include more related explanatory variables in the model. However such a problem as the inadequacy of price variation of product or the lack of price data is frequently encountered (Heien and Pompelli, 1988). The inadequate variation in price would somehow affect the significance of estimated parameters; the lack of price data makes it impossible to conduct a research on demand system.

It has been proved as an acceptable approach that, employ the Barten household model, the hedonic price can be estimated in place of actual price as a proxy to the

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lack of price (Barten 1964; Majumdar, 1988). Moreover, in the midst of Barten household model, the hypothesis of the household size effect model appears as an ideal option because of its evident correspondence to reality.

This study is, first, to estimate the hedonic prices of five types of food in the household, and, second, to gauge the demand fuction by LA/AIDS (linear approximation almost ideal demand system) model which comprises socioeconomic variables, and then to calculate and analyze the estimated result. More specifically, this paper examines the consumption of five types of food--staple food, meat, fish and shellfish, vegetable, and fruit. Much of the data relies upon the Survey of Family Income and Expenditure (called I & E survey afterwards) in 1992 by the Directorate-General of Budget, Accounting and Statistics, Executive Yuan, R.O.C., to accomplish the two following objectives:

a. To explore the appropriateness of the five major foods actual price being replaced by the hedonic price that respective families confront by applying Barten household size effect model.

b. To estimate the demand system model of the five major foods by the LA/AIDS method which includes socioeconomic variables.

2. Assumption:

The following presumptions are grounded in the characteristics of the data, the design of the model, and the empirical necessity.

a. Some expenses on a small portion of products are left blank in I & E survey. That particular part has been removed from the whole sample. Originally, the total number of the families surveyed is 16,434; however, this paper takes 15,944 into account. Since the sample is large enough, the efficiency is still remained in empirical result.

b. The per caput food supply per year is assumed to equate the consumption of an adult equivalent.

c. The adult equivalent in respective families are subject to the total population, the hierarchical population structure of age/gender differences, and the expenditure on individual food.

d. In the process of empiricizing, one is added to the size of respective age/gender hierarchy lest the logarithm of zero cannot be converted. By so doing, it only affects intercept value; the estimated parameters of slope of each variable is remain unchanged.

e. Only estimating the demand system of five types of food, the utility separability and aggregation as well as the satisfaction of the utility maximization principle in the two-stage budget allocation are all met.

II. Barten Household Size Effect Model

In demand system analysis, it is necessary to substitute the actual price lacking with the hedonic price. One way to do is to use "average price index" to substitute for it (Meng Jang Lin, 1993). This implies that respective families (or consumers) are capable of getting sufficient information and they resemble one another in terms of the variations in their preferrence for products (Deaton and Muellbauer, 1980). This presumption, not conforming to reality, is not adopted in this paper.

1. The Model

The use of Barten household model is mainly in the estimation of adult equivalent. The consumption of respective food by consumers depends upon their need of nutrition, gender, age, and/or even the number of their family members. This is exactly what Barten household size effect model is grounded in.

Barten household model supposes that utility would be changed by the product consumption which has been modified by specified scale factor i.e.,

(1) $U = U(Q_1/Y_1, \cdots, Q_n/Y_n)$

(2) $Y_i = Y_i(N_1, \cdots, N_k)$

Where Y_i (i=1, ··· ,n) denotes the adult equivalent of that particular household size after the ith product has been weighted

N_k (k=1,···,K) represents the population of the kth hierarchy of age/gender

Under budget constraint, the maximization of utility function can be expressed as follows:

(3) MAX $U = U(Q_1^*, \cdots, Q_n^*)$

(4) S.T. $\sum P_i^* Q_i^* = M$

(5) Where $Q_i^* = Q_i / Y_i$

(6) $P_i^* = P_i Y_i$

M: denotes disposable income

According to the first-stage condition of the utility maximization, the Marshallian demand fuction is derived as follows:

(7) $Q_i^* = Q_i^*(P_1^*, \cdots, P_n^*; M)$, or

(8) $Q_i = Y_i Q_i^*(P_1 Y_1, \cdots, P_n Y_n; M)$

Using X_i as the ith product expenditure, the Engel relationship of equation (8) can be modified as follows:

$$(9)\quad X_i = Y_i X_i (M / Y_i)$$

Due to the differences in theoretical hypotheses, three models in the estimation of adult equivalent of Barten household model have been proposed: the general scale model, specific scale model and household size effect model. General scale model assumed that differences in age/gender hierarchy give rise to different adult equivalent but adult equivalent do not change because of food item; specific scale model suggested that, both age/gender hierarchy and types of food have impactation on adult equivalent; household size effect model assumed that, in addition to age/gender hierarchy and types of food, adult equivalent is affected by family size as well.

2. The Setting and The Estimation of Household Size Effect Model

As far as the ith food is concerned, the equation listed below shows that household size effect does exist.

$$(10)\quad d(dX_i / dN_k) / dN_h \neq 0,\ h \neq k$$

Under the linear budget constraint if the changes of family size and age/gender hierarchy is to incresse expenditure on some foods ($dX_i/dN_k>0$) will diminish expenses on the others ($dX_j/dX_k<0$). Thus, the equation of linear budget constraint denotes:

$$(11)\quad \sum (dX_i / dN_k) = 0, \text{ and}$$

$$(12)\quad \sum [d(dX_i / dN_k) / dN_k] = 0$$

As a result, hous^hold size effect produces these three situations:

$$(13)\quad dX_i / dN_k > 0, \text{ and } [d(dX_i / dN_k) / dN_h] < 0$$

$$(14)\quad dX_i / dN_k < 0, \text{ and } [d(dX_i / dN_k) / dN_h] < 0$$

$$(15)\quad dX_i / dN_k > 0, \text{ and } [d(dX_i / dN_k) / dN_k] < 0$$

The equation (15) is called household size effect with economies of scale , i.e., when the population (N_k)of the kth age/gender hierarchy increases, the expenditure on the ith food will be raised in a decreasing rate.

The general equation of household size effect model is an extension from the specific scale model. Based on the hypothesis of specific scale model, the equation (9) can be re-written as:

(16) $X_i = Y_i X_i(m/Y_0)$

(17) $Y_i = W_{ik} N_k$

Where Y_0 is the scale (weighted household size) for income, and is replaced by the unweighted family population (N). W_{ik} is the weight of the kth age/gender hierarchy for product i. Substituting equation (17) into equation (16) gives the following specific scale model.

(18) $X_i = a_i W_{ik} N_k + b_i(m/N) W_{ik} N_k$, or

(19) $X_i = B_{ik}\left[N_k\left(A_i + m/N\right)\right]$

(20) Where $B_{ik} = b_i W_{ik}$

(21) $A_i = a / b_i$

The household size effects is not included in the specific scale model. The weight, W_{ik}, in equation (17) is then modified as:

(22) $W_{ik} = W^0_{ik} + W^1_{ik} N$

Substituting equation (22) into equation (17) gives the following expression for Y_i:

(23) $Y_i = \left(W^0_{ik} + W^1_{ik} \times N\right) \times N_k$

Substituting equation (23) into equation (16) gives the general function of the household size effect model.

(24) $X_i = \sum_k P_{ik}\left[N_k(A_i + M/N)\right] + \sum_k M_{ik}\left[N_k\left(A_i + M/N\right)N\right]$

(25) Where $P_{ik} = b_i W^0_{ik}$

(26) $M_{ik} = b_i W^1_{ik}$

P_{ik}: Parameters without household size effect
M_{ik}: Parameters with household size effect. Economies of scale exist for product i with respect to age/gender hierarchy if M_{ik}<0

Household size effect model is a non-linear function; through the program of PROC SYSNLIN SUR of SAS, the parameters of the models and the result of adult equivalents can be figured out.

3. The Calculation of Adult Equivalents

First, to choose the kth age/gender hierarchy and household size t as the basic group, with the adult equivalent equal to 1, i.e.,

$$(27)\quad (P_{ih_t} + M_{ih_t}T)/(P_{ih_t} + M_{ih_t}T) = 1$$

The rest of the kth age/gender hierarchy and household size n can be shown as follows:

$$(28)\quad (P_{ih_n} + M_{ih_n}N)/(P_{ih_t} + M_{ih_t}T)$$

In the equation (28), P_{ih_t} and $M_{ih_t}T$ are the parameters without household size effect and with household size effect in respective basic group of food. P_{ih_n} and $M_{ih_n}N$ are the parameters without household size effect and with household size effect in respective non-basic group of food.

III. Almost Ideal Demand System

1. Model and Estimation

AIDS (almost ideal demand system) was first made public by Deaton & Muellbauer in 1980. When AIDS is presented in the form of the expenditure share on respestive food (W_i) and utility is converted to the fuction of total expenditure (M) and price (P) by indirect utility function, AIDS can be written as:

$$(29)\quad W_i = \alpha_i^* + \sum_j r_{ij} \ln P_j + \beta_i \ln(M / P^*)$$

After taking in socioeconomic variables, AIDS model can be extended as (Pollak and Wales, 1981):

$$(30)\quad W_i = \alpha_i^* + \sum_j \gamma_{ij} \ln P_j + \beta_i \ln(M / P^*) + \sum_t \rho_{it} V_t$$

Where α, β, γ, ρ are parameters to be estimated
P_j=the price of the jth food (j is included in i)
M=total expenditure

(31) $\ln P^* = \sum W_i P_i$ is the Stone linear price index
V_t=the socioeconomic variable
$\alpha_i^* = \alpha_i + \rho_{io}, \rho_{io}$ is the intercept of socioeconomic variable

Due to Stone linear price index, the above mentioned demand model is called as linear approximation almost ideal demand system. The adoption of LA/AIDS model entails the scrutiny of the three following linear hypotheses:

(32) aggregation $\sum_i \alpha_i' = 1,\ \sum_i r_{ij} = 0,\ \sum_i \beta_i = 0\ \sum_i \rho_i = 0$

(33) symmetry $r_{ij} = r_{ji}$

(34) homogeneity $\sum_j r_{ij} = 0$

LA/AIDS has a lot of advantages: is the first order approximation for any demand system as well as satisfing the consumer choice axiom; meeting the perfect aggregation condition among consumers; the consistency between its demand function and family budget data; the linear characteristics of the model makes it easy to estimate and test parameters in avoiding complicated non-linear estimation; the share equation which is derived under the first order condition of expenditure minimization is subject to the prices of all kinds of food, total expenditure, and socioeconomic variables; with the restriction of symmetry and homogeneity, there arises the phenomenon of seemingly unrelated among the residual of the equations.

This study adopts Zellners seemingly unrelated regression method (SUR) to estimate parameters, which possess the statistic features as consistency, asymptotic normal and asymptotic efficiency. In order not to be singular in the course of estimation, one equation is removed, i.e., only four of five share equations are calculated simultaneously. Continuous socioeconomic variables are treated as logarithm in the process of empiricizing.

2. The Caculation of Elasticity

Based on the estimation result, the Marshallian price elasticity, expenditure elasticity, and Hicks price elasticity can be worked out.

(a) Marshallian Price Elasticity

Other things being equal, except that the price of one type of food fluctuates 1%, the ratio of the change in consuming that particular food (ε_{ii}) and other types of food pertains to uncompensated price elasticity, which have own-price elasticity and cross-price elasticity (ε_{ij}). In cross-price elasticity there are gross substitute and gross complement effect.

(35) $\varepsilon_{ii} = \left(\gamma_{ii} / \omega_i \right) - \beta_i - 1$

(36) $\varepsilon_{ij} = (\gamma_{ij} / \omega_i) - \beta_i(\omega_j / \omega_i)$, $i \neq j$

(b) **Marshallian Expenditure Elasticity**

Other things being equal, except that expenditure level (m) fluctuate 1%, the ratio of each food consumption will be affected; the equation to measure this is as follows:

(37) $\eta_{im} = (\beta_i / \omega_i) + 1$

(c) **Hicks Price Elasticity**

Hicks price elasticity is the pure reaction to the ratio of the change in consuming each type of food in response to 1% price fluctuation of one type of food pertains to compensated price elasticity due to the exclusion of expenditure effect. Here, cross-price elasticity has two effects: net substitute and net complement; the equations to measure are:

(38) $\delta_i = (r_{ij}/\omega_i) + \omega_j - 1$

(39) $\delta_{ij} = (r_{ij}/\omega_i) + \omega_j ,\ i \neq j$

3. The Model Testing

When symmetry and homogeneity constraints are set, aggregation is met at the same time. Thus, the examination on symmetry and homogeneity constraints are enough. Whether I & E data complies with the symmetry and homogeneity in LA/AIDS can be tested by the method of Wald-X^2 with the null hypotheses as follows:

(40) $H_o: r_{ij} = r_{ji}$

(41) $H_o \sum_j r_{ij} = 0$

(42) $H_o: r_{ij} = r_{ji}\ \ \&\ \ H_o: \sum_j r_{ij} = 0$

Equation (40) is used to examine the null hypothesis of symmetry; equation (41) is employed to examine the null hypothesis of homogeneity; and equation (42) is used to examine both.

IV. Empirical Model and The Data

1. Household Size Effect Model

(43) $X_i = \sum_k P_{ik}\left[N_k(A_{ik}+m/N)\right] + \sum_k M_{ik}\left[N_k(A_{ik}+m/N)N\right] + \xi_i$, k=1, 2,…,9

(44) $X_{it} = \sum_k P_{itk}\left[N_k(A_{itk}+m/N)\right] + \sum_k M_{itk}\left[N_k(A_{itk}+m/N)N\right] + \xi_{it}$

$$(45)\quad X_F = \sum_k P_{Fk}\left[N_k\left(A_F + m/N\right)\right] + \sum_k M_{Fk}\left[N_k\left(A_F + m/N\right)N\right] + \xi_F$$

$$(46)\quad X_V = \sum_k P_{Vk}\left[N_k\left(A_V + m/N\right)\right] + \sum_k M_{Vk}\left[N_k\left(A_V + m/N\right)N\right] + \xi_V$$

$$(47)\quad X_{FR} = \sum_k P_{FRk}\left[N_k\left(A_{FR} + m/N\right)\right] + \sum_k M_{FRk}\left[N_k\left(A_{FR} + m/N\right)N\right] + \xi_{FR}$$

Variables Definition:

- Xi : The ith food expenditure, i=S, M, F, V, FR (unit: NT$)
  (S: staple food, M: meat, F: fish and shellfish, V: vegetable, FR: fruit
- N_k : Unweighted population of the kth age/gender hierarchy (unit: person)
- m : Total expenditure on the five types of food (unit: NT$)
- N : Household size (unit: person)
- P_{ik} : Estimated parameters of the ith food and the kth age/gender hierarchy without scale economies factors
- M_{ik} : Estimated parameters of the ith food and the kth age/gender hierarchy with scale economies factors
- A_i : Specific parameters of the ith food expenditure
- E_i : Regression residual of the ith food

2. LA/AIDS Demand System Model

$$(48)\quad W_i = \rho_{i0} + \sum_j \gamma_{ij} \ln P_j + \beta_i \ln(m/P^*) + \rho_{i1}\ln INC + \rho_{i2}CITY + \rho_{i3}TOWN$$
$$+\rho_{i4}\ln AGE + \rho_{i5}NADU + \rho_{i6}NCHI + \rho_{i7}AGRI + \rho_{i8}OCW + \rho_{i9}OCA$$
$$+\rho_{i10}EDP + \rho_{i11}EDM + \rho_{i12}EDS + \varepsilon_i \quad i = S, M, F, V, FR$$

$$(49)\quad W_M = \rho_{M0} + \sum_j \gamma_{Mj} \ln P_j + \beta_M \ln(m/P^*) + \rho_{M1}\ln INC + \rho_{M2}CITY + \rho_{M3}TOWN$$
$$+\rho_{M4}\ln AGE + \rho_{M5}NADU + \rho_{M6}NCHI + \rho_{M7}AGRI + \rho_{M8}OCW + \rho_{M9}OCA$$
$$+\rho_{M10}EDP + \rho_{M11}EDM + \rho_{M12}EDS + \varepsilon_M$$

$$(50)\quad W_F = \rho_{F0} + \sum_j \gamma_{Fj} \ln P_j + \beta_F \ln(m/P^*) + \rho_{F1}\ln INC + \rho_{F2}CITY + \rho_{F3}TOWN$$
$$+\rho_{F4}\ln AGE + \rho_{F5}NADU + \rho_{F6}NCHI + \rho_{F7}AGRI + \rho_{F8}OCW + \rho_{F9}OCA$$
$$+\rho_{F10}EDP + \rho_{F11}EDM + \rho_{F12}EDS + \varepsilon_F$$

$$(51)\quad W_V = \rho_{V0} + \sum_{i} \gamma_{Vi} \ln P_i + \beta_V \ln(m / P^*) + \rho_{V1} \ln INC + \rho_{V2} CITY + \rho_{V3} TOWN$$
$$+ \rho_{V4} \ln AGE + \rho_{V5} NADU + \rho_{V6} NCHI + \rho_{V7} AGRI + \rho_{V8} OCW + \rho_{V9} OCA$$
$$+ \rho_{V10} EDP + \rho_{V11} EDM + \rho_{V12} EDS + \varepsilon_V$$

$$(52)\quad W_{FR} = \rho_{FR0} + \sum_{i} \gamma_{FRi} \ln P_i + \beta_{FR} \ln(m / P^*) + \rho_{FR1} \ln INC + \rho_{FR2} CITY$$
$$+ \rho_{FR3} TOWN + \rho_{FR4} \ln AGE + \rho_{FR5} NADU + \rho_{FR6} NCHI + \rho_{FR7} AGRI$$
$$+ \rho_{FR8} OCW + \rho_{FR9} OCA + \rho_{FR10} EDP + \rho_{FR11} EDM + \rho_{FR12} EDS + \varepsilon_{FR}$$

Variables Definition

W_i : Expenditure share of the ith food, i=S, M, F, V, FR (unit: %)
P_i : Price of the ith food, i=S, M, F, V, FR (unit: NT$/kg)
P^* : STONE price index (unit: %)
m : Total expenditure on the five types of food (unit: NT$)
(use the total expenditure on the five types of food--m to replace the total expenditure--M)
INC : Family disposable income (unit: NT$)
CITY : Dummy variable of city area
TOWN : Dummy variable of town area
(omitted variable: country area)
AGE : Age of the family head (unit: years)
NADU : Number of adults (over age 20) in the family (unit: person)
NCHI : Number of children in the family (unit: person)
AGEI : Dummy variable of agricultural family
(omitted variable: non-agricultural family)
OCW : Family head is a white-collar
OCA : Family head is a farmer
(omitted variable: family head is a blue-collar)
EDP : Family head received elementry school education or lower
EDM : Family head received junior high education
EDS : Family head received senior high education
(omitted variable: family head received college education or higher)
ε_i : Regression residual of the ith food, i=S, M, F, V, FR
ρ_{i0}, γ_{ij}, β_i, ρ_{i1}, ρ_{i2},.........,ρ_{i12}: Parameters to be estimated

3. Data:

This research relies mainly upon the Survey of Family Income and Expenditure Data conducted in 1992 by the Directorate-General of Budget, Accounting and Statistics, Executive Yuan, R.O.C. The data of the available consumption quantity of the five major foods per capita come from "1992 Taiwan Food Balance Sheet" by Council of Agriculture, Executive Yuan, R.O.C. The data used is described in the following:

a. The family's hierarchy of age/gender is divided into nine groups: age 6 and below (pre-school age); age 7-12 (school age); age 13-19 (adolescence); age 20-45 (prime); age 46-64 (middle age); age 65 and over (old age). The adolescence, prime, and middle age are further divided according to gender difference.

b. In 1992, the total family expenditure on the five types of food is 81,806 NT$; the respective expenditures are: meat 19,120 NT$ (21.35%); fish and shellfish 18,497 NT$ (22.30%); fruit 15,636 NT$ (19.06%); vegetable 14,366 NT$ (17.68%) (See Tables 1 & 2).

c. In the sample, the average family size is 4.16 (persons); the respective size of 9 groups divided by age/gender is as follows: age 6 and below: 0.46 (person); age 7-12: 0.52 (person); age 13-19 male: 0.28 (person); age 20-45 male: 0.81 (person) age 46-64 male: 0.34 (person); age 13-19 female: 0.27 (person); age 20-45 female: 0.87 (person); age 46-64 female: 0.33 (person); age 65 and over: 0.28 (person) (See Table 1).

Table 1: Descriptive Statistics of the Variables in the Barten Household Size Effect Model

Unit: NT$

Variable	Variable Name	Mean	Standard Deviation
Expenditure on staple food	X_S	14,185.3	8,180.8
Expenditure on meat	X_M	19,120.2	10,591.8
Expenditure on fish and shellfish	X_F	18,497.9	10,672.6
Expenditure on vegetable	X_V	14,366.9	7,768.7
Expenditure on fruit	X_{FR}	15,636.3	10,928.3
Size of age 6 and below	N_1	0.46	0.80
Size of age 7-12	N_2	0.52	0.82
Size of age 13-19 male	N_3	0.28	0.58
Size of age 20-45 male	N_4	0.81	0.63
Size of age 46-64 male	N_5	0.34	0.48
Size of age 13-19 female	N_6	0.27	0.60
Size of age 20-45 female	N_7	0.87	0.63
Size of age 46-64 female	N_8	0.33	0.47
Size of age 65 and over	N_9	0.28	0.57
Total expenditure on the five types of food	m	81,806.5	38,182.8
Family size	N	4.16	1.76

Note: The sample comprises 15,944 families.

Table 2 Descriptive Statistic of the Variables in the LA/AIDS Model

Unit: NT$, NT$/kg, %

Variable	Variable Name	Mean	Standard Deviation
Expenditure share of staple food	W_S	0.1782	0.0671
Expenditure share of meat	W_M	0.2315	0.0561
Expenditure share of fish and shellfish	W_F	0.2230	0.0603
Expenditure share of vegetable	W_V	0.1768	0.0526
Expenditure share of fruit	W_{FR}	0.1906	0.0862
Price of staple food	P_S	22.2	10.4
Price of meat	P_M	70.8	33.3
Price of fish and shellfish	P_F	107.6	56.1
Price of vegetable	P_V	30.8	14.4
Price of fruit	P_{FR}	43.2	28.5
Total expenditure on the five type of food	m	81,806.5	38,182.8
Family disposable income	INC	641,771.9	398,480.8
City area	CITY	0.55	0.50
Town area	TOWN	0.28	0.45
Age of the family head	AGE	43.2	12.8
Number of adults	NADU	2.63	10.9
Number of children	NCHI	1.53	1.31
Agricultural family	AGRI	0.17	0.38
Family head is a white-collar	OCW	0.48	0.50
Family head is a farmer	OCA	0.10	0.30
Family head as a elementary school graduate or below	EDP	0.36	0.48
Family head as a junior high graduate	EDM	0.27	0.44
Family head as a senior high graduate	EDS	0.27	0.44

d. Through Barten household size effect model, the average value of the hedonic price of the five types of food in 1992 are: staple food 22.2 NT$/kg; meat 70.8 NT$/kg; fish and shellfish 107.6 NT$/kg; vegetable 30.8 NT$/kg; fruit 43.2 NT$/kg (See Table 2).

The average disposable income of the family in 1992 is 641,771.9 NT$ (See [illegible] 2). In the distribution of the families in the sample, families in the city count [illegible], families in the town 28%, families in the country 17%. The average age of the family head in the sample is 43.2 years. There are 2.63 adults and 1.53 children in the family size of 4.16 persons. Agricultural families count 17% and none-agricultural families count 83%. As for the family head's occupations, there are 48% white-collar, 10% farming, 42% blue-collar. The educational background of the family heads appears to be 36% of them as elementry school graduates, 27% junior high, 27% senior high, and 10% college or higher.

V. The Emipirical Result

1. Barten Household Size Effect Model

The estimated parameters without family size effect factors all pass the hypothetical test of the significantly different frome zero (P_1-P_9 in table 3); however, the statistical significance of the estimated parameters with family size effect factors (M_1-M_9 in table 3) appears uncertain. Those with expenditure scale economies (for instance, the staple food of age [illegible]0-45 male, M_4) show that the family expenditure on staple food increases as the size of that particular age/gender hierarchy becomes bigger though the increasing pace is getting slower and slower. Based on the estimated result, and through equations 43~47, this study calculates adult equivalents in correspondence to different family sizes under respective types of food and age/gender hierarchy (See Tables 4-1 to 4-5). As a result, through the age/gender structure, its adult equivalents which correspond with the five types of food of the family can be figured out. Then, by multiplying the annually available consumption per capita in Taiwan Food Balance Sheet with adult equivalents, the consumption quantity of the five types of food by respective families is derived; and then, by dividing the family expenditure on respective foods in the survey of I & E with consumption quantity, we can get hedonic price. The average value of the hedonic price of respective foods that the sample families have is listed on Table 2.

2. LA/AIDS Model

The comparison of Wald-X^2 calculated values and their correspondent critical values indicating that the conditions of symmetry, homogeneity, as well as symmetry and homogeneity are all significant at 10% level, the appropriation of the LA/AIDS model in this study is supported (Tables 5 and 6).

Table 3: The Estimated Result of Barten Household Size Effect Model

Variable		Staple Food	Meat	Fish and Shellfish	Vegetable	Fruit
Intercept		9612.8	-245.6	5783.7	1619.8	-3089.5
		(24.9)*	(-2.1)	(98.7)	(9.8)	(-19.3)
Estimated perameter (not including household size effect)						
Age 6 and below	P_1	0.117	0.242	0.253	0.158	0.230
		(34.5)	(28.6)	(26.5)	(23.6)	(18.8)
Age 7-12	P_2	0.118	0.250	0.249	0.150	0.233
		(33.7)	(28.5)	(25.3)	(21.7)	(18.4)
Age 13-19 male	P_3	0.136	0.249	0.205	0.119	0.290
		(25.2)	(18.3)	(13.6)	(10.9)	(14.9)
Age 20-45 male	P_4	0.129	0.209	0.239	0.147	0.276
		(38.9)	(28.2)	(29.1)	(24.6)	(26.2)
Age 46-64 male	P_5	0.113	0.206	0.252	0.188	0.242
		(28.7)	(20.4)	(22.9)	(23.1)	(16.9)
Age 13-19 female	P_6	0.117	0.225	0.249	0.168	0.242
		(23.8)	(17.4)	(17.4)	(16.3)	(13.1)
Age 20-45 female	P_7	0.120	0.209	0.255	0.167	0.249
		(37.6)	(27.2)	(30.4)	(26.9)	(22.8)
Age 48-64 female	P_8	0.109	0.241	0.286	0.175	0.191
		(28.7)	(24.7)	(27.1)	(22.3)	(13.8)
Age 65 and over	P_9	0.109	0.215	0.279	0.194	0.203
		(41.8)	(35.4)	(41.9)	(34.1)	(23.2)
Estimated perameter (including household size effect)						
Age 6 and below	M_1	0.0001	-0.001	0.004	-0.0003	-0.002
		(0.1)+	(-0.8)+	(2.0)	(-0.3)+	(-0.8)+
Age 7-12	M_2	-0.0004	-0.002	0.002	0.002	-0.001
		(-0.07)+	(-1.2)+	(0.9)+	(1.3)+	(-0.6)+
Age 13-19 male	M_3	-0.004	-0.002	0.012	0.008	-0.014
		(-3.6)	(-0.8)+	(4.0)	(3.8)	(-3.6)
Age 20-45 male	M_4	-0.002	0.005	0.003	0.003	-0.008
		(-3.9)	(3.1)	(1.6)+	(2.2)	(-3.6)
Age 46-64 male	M_5	0.001	0.007	0.003	-0.006	-0.004
		(0.9)+	(2.9)	(0.9)+	(-3.2)	(-1.2)+
Age 13-19 female	M_6	0.00005	0.003	0.001	-0.002	-0.003
		(0.05)+	(1.4)+	(0.4)+	(0.9)+	(-0.8)+
Age 20-45 female	M_7	-0.001	0.006	-0.001	-0.0006	-0.004
		(-1.6)+	(3.6)	(-0.3)+	(0.5)+	(-1.6)+
Age 48-64 female	M_8	0.001	-0.002	-0.005	-0.0008	0.007
		(1.5)+	(-0.8)+	(-1.9)	(-0.2)+	(1.9)
Age 65 and over	M_9	0.001	0.007	-0.004	-0.005	0.0005
		(1.6)+	(4.5)	(-2.1)	(-4.2)	(0.2)+

*: the figure in the bracket is t value.
+: not significant at 5% level.

Table 4-1: The Adult Equivalent of Staple Food of Respective Age/Gender Hierarchy in Different Household Size

Size of family	age 6 and below	age 7-12	age 13-19 male	age 20-45 male	age 46-64 male	age 13-19 female	age 20-45 female	age 46-64 female	age 65 and over
1	0.97	0.97	1.09	1.05	0.94	0.97	0.98	0.91	0.91
2	0.97	0.97	1.06	1.03	0.95	0.97	0.98	0.92	0.92
3	0.97	0.97	1.02	1.02	0.96	0.97	0.97	0.92	0.93
4	0.97	0.96	0.99	1.00	0.97	0.97	0.96	0.93	0.93
5	0.97	0.96	0.96	0.98	0.98	0.97	0.95	0.94	0.94
6	0.97	0.96	0.93	0.97	0.98	0.97	0.94	0.95	0.95

Table 4-2: The Adult Equivalent of Meat of Respective Age/Gender Hierarchy in Different Household Size

Size of family	age 6 and below	age 7-12	age 13-19 male	age 20-45 male	age 46-64 male	age 13-19 female	age 20-45 female	age 46-64 female	age 65 and over
1	1.05	1.08	1.08	0.93	0.93	1.00	0.94	1.04	0.97
2	1.05	1.08	1.08	0.93	0.93	1.00	0.94	1.04	0.97
3	1.04	1.07	1.06	0.98	0.99	1.02	0.99	1.03	1.03
4	1.04	1.06	1.05	1.00	1.02	1.03	1.02	1.02	1.06
5	1.03	1.05	1.04	1.02	1.05	1.05	1.04	1.01	1.09
6	1.03	1.04	1.03	1.04	1.08	1.06	1.07	1.00	1.12

Table 4-3: The Adult Equivalent of Fish and Shellfish of Respective AGe/Gender Hierarchy in Different Household Size

Size of family	age 6 and below	age 7-12	age 13-19 male	age 20-45 male	age 46-64 male	age 13-19 female	age 20-45 female	age 46-64 female	age 65 and over
1	1.02	1.00	0.86	0.96	1.02	1.00	1.01	1.12	1.10
2	1.02	1.00	0.86	0.96	1.02	1.00	1.01	1.12	1.10
3	1.06	1.02	0.92	0.99	1.04	1.00	1.00	1.08	1.06
4	1.07	1.02	1.01	1.00	1.05	1.01	1.00	1.06	1.05
5	1.09	1.03	1.06	1.01	1.06	1.01	1.00	1.04	1.03
6	1.10	1.04	1.10	1.02	1.08	1.02	0.99	1.02	1.02

Table 4-4: The Adult Equivalent of Vegetable of Respective Age/Gender Hierarchy in Different Household Size

Size of family	age 6 and below	age 7-12	age 13-19 male	age 20-45 male	age 46-64 male	age 13-19 female	age 20-45 female	age 46-64 female	age 65 and over
1	0.99	0.96	0.80	0.94	1.14	1.04	1.05	1.10	1.19
2	0.99	0.96	0.80	0.94	1.14	1.04	1.05	1.10	1.19
3	0.99	0.98	0.90	0.98	1.07	1.02	1.04	1.09	1.13
4	0.99	0.99	0.95	1.00	1.03	1.01	1.04	1.08	1.09
5	0.98	1.01	1.00	1.02	0.99	0.99	1.03	1.08	1.06
6	0.98	1.02	1.02	1.04	0.96	0.98	1.03	1.07	1.03

Table 4-5: The Adult Equivalent of Fruit of Respective Age/Gender Hierarchy in Different Household Size

Size of family	age 6 and below	age 7-12	age 13-19 male	age 20-45 male	age 46-64 male	age 13-19 female	age 20-45 female	age 46-64 female	age 65 ane over
1	0.93	0.95	1.13	1.10	0.98	0.98	1.00	0.81	0.83
2	0.93	0.95	1.07	1.07	0.96	0.98	0.99	0.84	0.84
3	0.92	0.94	1.02	1.03	0.94	0.95	0.97	0.87	0.84
4	0.91	0.94	0.96	1.00	0.93	0.94	0.95	0.90	0.84
5	0.90	0.93	0.90	0.98	0.91	0.93	0.94	0.93	0.84
6	0.80	0.93	0.84	0.93	0.89	0.92	0.92	0.95	0.84

Table 5: The Statistical Testing of Homogeneity and Symmetry Condition in LA/AIDS Model

Item	WALD-X^2		D.F.
	I	II	
Symmetry	5.78	5.78	4
Homogeneity	3.04	6.92	6
Symmetry and Homogeneity	2.66	2.66	10

Note: I is the calculated WALD-X^2 of the expenditure share equations in W_S, W_M, W_F and W_P.

II is the calculated WALD-X^2 of the expenditure share equations in W_M, W_F, W_P, W.

$X^2_{0.005(4)}$=9.49 $X^2_{0.05(6)}$=12.59 $X^2_{0.05(10)}$=18.31.

a. Economic Variables

The estimated result of the model (See Table 6) shows that the estimated parameters of economic variables are accepted with statistical significance except that a change in the total expenditure on the five types of food does not affect the expenditure share of fish and shellfish. Marshallian own price elasticity for the five foods is disclosed as staple food -0.2367, meat -0.3256, fish and shellfish -0.2987, vegetable -0.2769, fruit -0.2626 (See Table 7). As for Hicks own price elasticity, the staple food is estimated as -0.2804, meat as -0.3459, fish and shellfish as -0.3402, vegetable as -0.5538, and fruit and -0.5022.

Table 6: The Estimated Result of the LA/AIDS Model

Item		Expenditure Share of Staple Food	Expenditure Share of Meat	Expenditure Share of Fish and Sellfish	Expenditure Share of Vegetable	Expenditure Share of Fruit
Intercept		0.248	0.051	0.077	0.250	0.374
		(38.6)*	(9.4)	(13.3)	(44.0)	(37.8)
Economic variables						
Price of staple food	P_S	0.138	-0.040	-0.038	-0.028	-0.031
		(475.3)	(-190.5)	(-187.7)	(-137.0)	(-145.8)
Price of meat	P_M	-0.040	0.159	-0.045	-0.036	-0.039
		(-190.5)	(500.7)	(-189.5)	(-159.8)	(-212.1)
Price of fish and shellfish	P_F	-0.038	-0.045	0.156	-0.036	-0.038
		(-187.7)	(-189.5)	(510.4)	(-162.0)	(-190.3)
Price of Vegetable	P_V	-0.028	-0.036	-0.036	0.128	-0.028
		(-137.0)	(-159.8)	(-162.0)	(437.9)	(-144.7)
Price of fruit	P_{FR}	-0.031	-0.039	-0.038	-0.028	0.136
		(-145.8)	(-212.1)	(-190.3)	(-144.7)	(373.6)
Total expenditure of five types of food	m	0.009	0.014	-0.0001	0.002	-0.025
		(11.7)	(22.9)	(-0.1)+	(3.4)	(-22.1)
Family disposable in come	INC	0.002	-0.001	-0.003	-0.004	0.006
		(6.6)	(-3.9)	(-10.8)	(-13.6)	(11.5)
Socioeconomic variables						
City area	CITY	0.002	-0.001	-0.001	-0.001	-0.005
		(6.6)	(-1.4)+	(-3.5)	(-1.4)+	(-7.2)
Town area	TOWN	0.003	0.001	-0.008	0.001	-0.004
		(7.6)	(3.0)	(-2.1)	(1.6)+	(-6.1)
(Omitted variable: rural area)						
Age of family head	AGE	-0.004	0.003	0.007	0.011	-0.017
		(-8.0)	(7.4)	(15.0)	(23.2)	(-20.3)
Size of adults	NADU	-0.014	-0.009	0.004	-0.002	0.013
		(-16.4)	(-1.2)+	(5.5)	(-2.0)	(9.2)
Size of children	NCHI	-0.004	0.0004	0.0001	-0.006	0.009
		(-7.6)	(1.1)+	(0.2)+	(-14.6)	(12.6)
Agricultural family	AGRI	-0.0001	-0.001	-0.001	0.002	0.001
		(-0.3)+	(-2.0)	(-3.3)	(3.5)	(1.1)+
(Omitted variable: non-agricultural family)						
Family head is a white-collar	OCW	0.002	-0.001	-0.001	-0.001	0.0002
		(5.8)	(-2.3)	(-2.7)	(-2.4)	(0.4)+
Family head is a farmer	OCA	0.003	-0.001	-0.001	-0.001	0.0003
		(6.0)	(-3.0)	(-2.7)	(-2.0)	(0.4)+
(Omitted variable: family head is a blue-collar)						
Family head received elementary school education or lower	EDP	0.003	-0.00003	-0.003	-0.001	0.001
		(4.6)	(-0.1)+	(-5.8)	(-1.8)	(1.3)+
Family head received junior high education	EDM	0.003	0.000009	-0.002	0.0002	-0.001
		(5.6)	(0.02)+	(-5.0)	(0.5)+	(-1.1)+
Family head received senior high education	EDS	0.002	0.0003	-0.001	0.0003	-0.002
		(4.8)	(0.9)+	(-2.2)	(0.6)+	(-2.6)
(Omitted variable: family head received college education and higher)						

Note: System R^2=0.933.

*: the figure in the bracket is t value.

+: not significant at 5% level.

The fact that Marshallian cross-price elasticities are all minus and Hicks cross-price elasticity are all plus explains the relatioship of gross complement and net substitute. In other words, expenditure effect is larger than substitute effect. Figure 1 shows the relationship of gross complement and net substitute; for example, when the price of staple food is raised from P_s^0 to P_s^1, the consumption of meat decreases from a to c. In fact, substitute effect is from a to b; when the price of staple food is going upward, the consumption of the meat is higher. But, when other conditions remain unchanged, th expenditure effect of the purchasing power decrease caused by the price increase is from b to c. That is to say, the decreasing amount ($\overline{bc}$) of meat consumption caused by expenditure effect is larger than the increasing amount ($\overline{ab}$) of substitute effect.

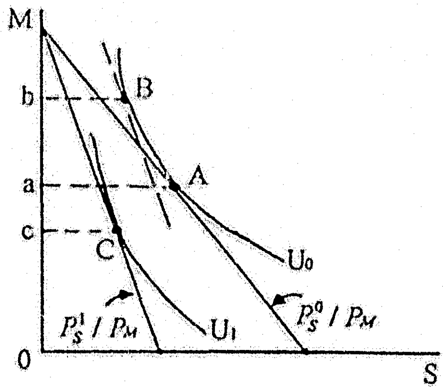
Table 7: Marshallian Price Elasticity and Expenditure Elasticity

Item	Staple Food	Meat	Fish and Shellfish	Vegetable	Fruit
Price of staple food	-0.2367	-0.1837	-0.1700	-0.1619	-0.1415
Price of meat	-0 2357	-0.3256	-0.1998	-0.2050	-0.1749
Price of fish and shellfish	-0.2235	-0.2060	-0.2987	-0.2078	-0.1684
Price of vegetable	-0.1669	-0.1651	-0.1625	-0.2769	-0.1241
Price of fruit	-0.1852	-0.1801	-0.1686	-0.1601	-0.2616
Total expenditure of five types of food	1.0480	1.0605	0.9996	1.0124	0.8706

Table 8: Hicks Price Elasticity

Item	Staple Food	Meat	Fish and Shellfish	Vegetable	Fruit
Price of staple food	-0.2804				
Price of meat	0.0299	-0.3459			
Price of fish and shellfish	0.0454	0.1364	-0.3402		
Price of vegetable	0.1040	0.1266	0.0805	-0.5538	
Price of fruit	0.0763	0.1152	0.1152	0.1685	-0.5022

Figure 1. Gross Complement and Net Substitute



a. Socioeconomic Variables

(i) The Expenditure Share on Staple Food:

Families in city and town areas spend more on staple food than those in areas. The expenditure share on staple food lessens as the family head is getting older and the number of adults and children becomes larger. Families whose heads are agricultural and white-collar workers spend more on staple food than those with blue-collar heads. Families whose heads are college graduates or higher spend less on staple food than the rest of the families.

(ii) The Expenditure Share on Meat

The expenditure share of families in towns is more than those in the rural area. There is no clear distinction between those in cities and in the rural area. The age of the family head and the family expenditure share on meat is in direct proportion to each other. The number of adults and children as well as the family head's educational background have nothing to do with the family expenditure share on meat. Agricultural families spend less on meat share than non-agricultural families. Families whose heads are blue-collar spend more on meat than those with white-collar heads and farmer heads.

(iii) The Expenditure Share on Fish and Shellfish

The expenditure share in city and town areas is less than in rural areas. The age of the family head and the number of adults are in direct proportion to the family expenditure share on fish and shellfish. The number of children in the family has no connection with the expenditure share. Agricultural families spend less on fish and shell fish than non-agricultural families. Families whose heads are white-collar workers and farmers spend less than those with blue-collar family heads. As for the relation of the family head's educational background to the expenditure, we see the expenditure of families whose heads received college education or higher is, in turn, higher than families whose heads receiving high school education and families whose heads receiving elementary education or lower.

(iv) The Expenditure Share on Vegetable

In terms of expenditure share on vegetable, there is no clear distinction among different areas. The age of the family head is in direct proportion to the expenditure share on vegetable, however, the number of adults and children is in inverse proportion to the expediture portion on vegetable. The expenditure of agricultural families on vegetable is more than that of non-agricultural families. Families whose heads are blue-collar spend more on vegetable than those whose heads are white-collar workers and farmers. Families whose heads are elementary graduates or below spend less on vegetable than those whose heads received college education or higher. But there is no clear distinction of the expenditure on vegetable among families whose heads received junior high, senior high and college education.

(v) The Expenditure Share on Fruit

The expediture on fruit in rural areas is more than those in city and town areas. The age of the family head is in inverse proportion to the family expenditure share on fruit. The number of adults and children and the expenditure on fruit is in direction proportion. There is no difference between agricultural and non-agricultural families in this particular expenditure share. The occupation of the family head has nothing to do with the fruit expenditure share. As for the relation of the family head's educational background to the expenditure, we see no evident distinction betwene families whose heads received high school education or lower and families whose heads received college education or higher.

VI. Conclusion

This study, based on Barten household size effect model, estimates the hedonic price in place of the actual price of the family's five major foods as a proxy. The comparison between hedonic price and actual price as well as the estimated reasult of LA/AIDS empirical model well demonstrate the academic and pragmatic value of the methodology employed here.

Marshallian own price elasticity of the five major foods ranges from -0.2367 to -0.3256. Hicks own price elasticity ranges from -0.2804 to -0.5538. Both elasticity figures are not considered big. As food supply changes, the producer surplus is easily affected by unstable price. The cross-price elasticity of the estimated result indicates the relationship between the five types of food as "gross complement and net substitute" proves that expenditure effect is larger than substitute effect and the net substitute among foods is not considered big.

This study adopts the data of "I & E" survey, which possesses the statistic advantages of a large sample because of its extensive data observed. There is a certain degree of relevance and influence between different socioeconomic variables on the expenditure share of the five types of food. This study might serve as a reference for the private enterprises' marketing strategy in the market segmentation and in the selection of target market as well as for policy evaluation by the public sectors.

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