Estimating Consumption Profiles for Taiwan

This document summarizes the data and methodology used in estimating consumption age-profiles for Taiwan, for the years 1977 through 2003.

Data

Data for estimation was obtained from the Family Income/Expenditure Survey (FIES) of Taiwan, for the years 1976-2003. The FIES is sponsored annually by the Directorate-General of Budget, Accounting and Statistics (DGBAS), with data collection conducted by local governments. Survey coverage is designated to be the civilian, non-institutionalized population of Taiwan; with annually selected cross-sectional samples comprised of over 13,000 households since 1978.[1] Households are subject to an annual interview, with selected households requested to maintain daily diaries of household income and expenditures to serve as a form of quality control.

Information contained in the FIES is collected on household composition, housing conditions, individual income, and household expenditures. Reference period for the data collected is the one-year period of January 1st through December 31st, with data collected the following January and February. Each year's information is provided within two data sets—household and individual. Household data sets contain detailed information on household consumption expenditures and housing; individual data sets provide individual demographic, employment, and income information. For the purposes of consumption allocation and estimation, information from both data sets is required.

---

[1] Sample sizes for year 1976 and 1977 stand at 9,441 and 9,661 households, respectively. Since 1978, the sample size has varied between 13,601 (2002) and 16,434 (1983 and 1984).

Allocating Household Consumption to Individual Members

Individual consumption is estimated as the sum of four components to be allocated separately. The three components are health, education, housing and other consumption. Other consumption is defined simply as consumption less health, education and housing.

Allocating Health

Household consumption on health includes expenditures on medical equipment and instruction; treatment in hospitals, hospital services, and health insurance; expenditures on medical articles; and personal accident and medical premiums. The summation of these components yield reported expenditure on medical care and sanitation, which is defined as household private health expenditures in the case of Taiwan.

The methodology used in the final health expenditure estimates assumes usage costs can be modeled as a cubic in age, and exploits available data in the FIES on the number of days hospitalized and number of outpatient visits for all individuals.

The underlying assumptions are intuitive. Household health expenditures are the sum of the products of household health usage and their estimated prices. Health expenditure for household i is given by

$$H_j = \sum_i \sum_k P^k X_{ij}^k .$$ (1.1)

P^k is the estimated price of health care product k, and X_{ij}^k is the usage of product k by individual i in household j. Application of this method requires data on household health expenditures, H_j and some indicator of health care usage at the individual level X_{ij}^k.

We assume prices for each health product follow a cubic in age, such that:

$$P^k = \alpha_0^k + \alpha_1^k age_i + \alpha_2^k age_i^2 + \alpha_3^k age_i^3 \tag{1.2}$$

Substitution of prices into the household health expenditure equation yields the following:

$$H_j = \sum_k \left(\alpha_0^k \sum_i X_{ij}^k + \alpha_1^k age_i \sum_i X_{ij}^k + \alpha_2^k age_i^2 \sum_i X_{ij}^k + \alpha_3^k age_i^3 \sum_i X_{ij}^k \right). \tag{1.3}$$

Coefficients from the above regression are used to estimate prices of each health care product, which are used to estimate individual health expenditures. The estimated expenditures are used to calculate the share of household health expenditure allocated to each member.

To better illustrate, we detail the specification and methodology used in estimating Private Health Expenditures in Taiwan. The specification used for Taiwan NHI, which has two health indicators available (number of days hospitalized I_i and number of outpatient visits O_i) is:

$$\begin{aligned}
H_j &= \alpha_0^I \sum_i X_{ij}^I + \alpha_1^I age_i \sum_i X_{ij}^I + \alpha_2^I age_i^2 \sum_i X_{ij}^I + \alpha_3^I age_i^3 \sum_i X_{ij}^I \\
&+ \alpha_0^O \sum_i X_{ij}^O + \alpha_1^O age_i \sum_i X_{ij}^O + \alpha_2^O age_i^2 \sum_i X_{ij}^O + \alpha_3^O age_i^3 \sum_i X_{ij}^O
\end{aligned} \tag{1.4}$$

Data on X_{ij}^k and *age* are provided in the FIES, thus e regress the products of household health usage indicators and age factors on household NHI, and use the estimated coefficients to obtain estimated prices and predicted individual expenditures based on individual age and health usage. [2]

---

[2] This same methodology was used on the unallocated portion of household National Health Insurance (NHI) benefits in public health consumption estimates.

In the case of Taiwan, we further modified the general specification. A dummy for individuals aged 0 was added to the price equation to better account for the uniqueness of health expenditures for newborns. Thus, the price equation became:

$$P^k = \alpha_0^k + \alpha_1^k age_i + \alpha_2^k age_i^2 + \alpha_3^k age_i^3 + \alpha_4^k age0_i . \tag{1.5}$$

The variable $age0_i$ is a dummy which equals one if the individual's reported age is zero, and zero otherwise. The specification in Equation (1.4) becomes

$$
\begin{aligned}
H_j &= \alpha_0^I \sum_i X_{ij}^I + \alpha_1^I age_i \sum_i X_{ij}^I + \alpha_2^I age_i^2 \sum_i X_{ij}^I + \alpha_3^I age_i^3 \sum_i X_{ij}^I + \alpha_4^I age0_i \sum_i X_{ij}^I \\
&+ \alpha_0^O \sum_i X_{ij}^O + \alpha_1^O age_i \sum_i X_{ij}^O + \alpha_2^O age_i^2 \sum_i X_{ij}^O + \alpha_3^O age_i^3 \sum_i X_{ij}^O + \alpha_4^O age0_i \sum_i X_{ij}^O
\end{aligned}
\tag{1.6}
$$

Regression is undertaken at the household level, and the coefficients are used to obtain prices as a function of individual age following Equation (1.5), and individual expenditures. Estimated individual expenditures are the predicted values of (1.6), using individual age and health usage data:

$$
\begin{aligned}
CFH_{ij}^* &= \alpha_0^I X_{ij}^I + \alpha_1^I age_i X_{ij}^I + \alpha_2^I age_i^2 X_{ij}^I + \alpha_3^I age_i^3 X_{ij}^I + \alpha_4^I age0_i X_{ij}^I \\
&+ \alpha_0^O X_{ij}^O + \alpha_1^O age_i X_{ij}^O + \alpha_2^O age_i^2 X_{ij}^O + \alpha_3^O age_i^3 X_{ij}^O + \alpha_4^O age0_i X_{ij}^O
\end{aligned}
\tag{1.7}
$$

These predicted expenditures are then used to calculate the share of household health expenditures which are allocated to each individual for NHI and CFH.

$$CFH_{ij} = CFH_j \frac{CFH_{ij}^*}{\sum_i CFH_{ij}^*} \tag{1.8}$$

One problem encountered in estimating and allocating health expenditures for individuals was the lack of individual data on health usage for those years prior to implementation of National Health Insurance (NHI). For years after 1994, the FIES collects data on

individual NHI expenditures and health usage related to these expenditures, including the two health usage indicators described above.

However, for years 1994 and prior, individual health usage data is not available. Thus, for these earlier years, we assume individual health usage follows the per capita smoothed profile for 1996. Health usage is assigned to individuals based on age, and is equal the mean by age from the 1996 FIES.[3]

$$O_i^t(age) = \overline{O^{1996}}(age) \tag{1.9}$$

Estimation is then completed, following (1.4). An age 0 dummy was no longer included.

Allocating Education

Allocation of household education expenditures for Taiwan is slightly less complex than that of health expenditures, though following a similar methodology. Household expenditures on education (CFE_j) are defined as books, supplies, tuition, fees, and private tutoring expenses. Household education expenditure is regressed upon the number enrolled individuals in the household by age group.

There are several difficulties that were encountered in allocating household education expenditures for Taiwan, and which required correcting adjustments in methodology. Information on student enrollment was limited to those enrolled in primary education and higher, and those with reported employment status of "student". Thus, under the basic methodology (utilizing the number of enrolled in each age group), children in preschool were not allocated educational consumption (as preschool enrollees were not included in

---

[3] Estimation for earlier years was also undertaken with smoothed mean health usage profiles for 2003. The estimates obtained were consistent with those presented here using the 1996 profiles.

the definition of student), although most preschools are private and relatively expensive.

Furthermore, expenditures for those who attend school on a secondary basis (e.g. those whose primary status is as employed, but are possibly students part-time) were not allocated. These individuals are generally from older age groups.

Household education expenditures were thus regressed on enrolled students ($E_j(a)$) aged 6 and above, non-enrolled students ($NE_j(a)$) aged 6 and 7, and total children ($N_j(a)$) aged 3 through 5.

$$CFE_j = \sum \alpha(a)E_j(a) + \sum \beta(a)NE_j(a) + \sum \varphi(a)N_j(a) \qquad (1.10)$$

Children aged 3 thorough 5 were included to account for expenditures of those enrolled in preschool. Non-enrolled aged 6 and 7 accounted for expenditures on those in transition between preschool and primary school, who may not have been reported as enrolled. Further complications were encountered in the 2002 and 2003 data, as the DGBAS adopted a stricter definition of "student", resulting in many of those in the 6 and 7 year old age groups no longer being classified as students.[4] Exclusion of those non-enrolled aged 6 and 7 would result in significant under-reporting of educational expenditures for these age groups.

Coefficients of the regression were assigned to individuals based on age and enrollment status; individuals who were not represented in the regression were assigned a value of zero. As with health expenditures, a household total for coefficients was calculated, and each individual was assigned a share of household expenditures. This share was then

---

[4] Prior to 2002, a child is considered a student if s/he attends school the previous year. In 2002, the definition of student was changed to count only those children who attended school for at least 6 months in the previous year.

multiplied by reported household educational expenditures to obtain the education expenditure allocated to each individual member.

Once education expenditures have been allocated to individuals, the age profile is obtained, defined as the per capita individual education expenditure by age.

Allocating Other Consumption

Other consumption is defined as total consumption less consumption of education, health and housing. In the case of Taiwan, household other consumption is obtained by subtracting expenditure on education, culture, and researches; medical care and sanitation expenditures; and implicit rent (gross rent less water charges) from total household consumption expenditure.

To accommodate the current treatment of indirect taxes, the allocation of other consumption is divided into three parts: estimation of tobacco, alcohol, and the remaining other consumption. Tobacco and alcohol are allocated separately using a regression method. The household expenditures on tobacco and alcohol are regressed on the number of household members, by five-year age groups. Only adult household members, those over the age of 15, are included in the regression, with an upper open age group of 70+. Coefficients of estimation are then assigned to individuals based on age. Allocation proceeds following the method previously described for health and education: total estimated household consumption is calculated based on individual assigned coefficients, and estimated shares of household consumption are derived. Consumption by an individual of tobacco or alcohol is estimated to be this estimated share multiplied by actual household consumption of tobacco or alcohol.

The remaining other consumption (less tobacco and alcohol) is allocated using an *ad hoc* allocation rule based on an extensive review of the literature and other estimation methods.

Consumption of individuals is assumed to be proportional to an equivalence scale that is equal to 1 for adults aged twenty or older, increases linearly from age 4 to age 20 from 0.4 to 1, and is constant at 0.4 for children below age 5:
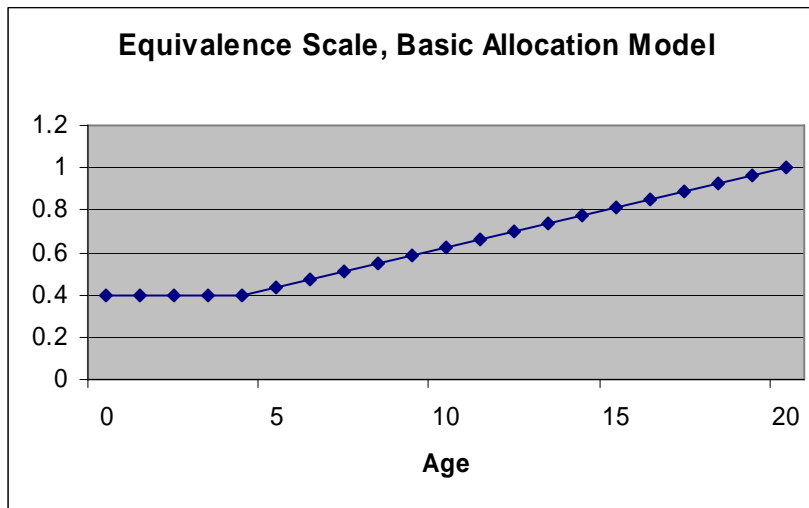
The scale is calculated using the following formula:

$$\alpha(a) = 1 - 0.6 \times (4 < a < 20) \times \left[\frac{20-a}{16} \right] - 0.6 \times (a \le 4) \qquad (1.11)$$

Following this rule, equivalence scales are assigned to all individuals, and summed by household to obtain the number of equivalent adults within a household. An individual's *i*'s share of household other consumption is then his/her associated equivalence scale, $\alpha_i(a)$, divided by the total number of equivalent adults in the household. This share is then multiplied by household other consumption to obtain allocated other consumption for individual *i* in household *j*:

$$CFX_{ij} = CFX_j \frac{\alpha_i(a)}{\sum \alpha(a)M_j(a)} \tag{1.12}$$

The age profile of other consumption is then obtained through the summation of the components of other consumption (tobacco, alcohol, other (less tobacco and alcohol)), and the profile is obtained as the per capita other consumption by age.

Housing Consumption

Housing consumption is allocated using the linear equivalence scale in Equation (1.11), and follows the methodology for allocating household other consumption (less alcohol and tobacco).

Combined (Total) Consumption

Total consumption is defined to be the sum of education, health, housing and other consumption. This was obtained by summing across the components by age. Summation was done using the age profiles obtained, although summation by individuals would yield identical results. Estimated profiles, with the exception of education[5], were smoothed in Stata using the *Lowess* method with a bandwidth of 0.1 (smoothing).

Age-Profiles of Consumption

Age-profiles of consumption are estimated per capita total consumption, calculated by age. The code used to estimate age-profiles of consumption and its components using Stata is contained in the following file: Consumption Code

---

[5] Estimated education consumption values were not smoothed, as the appropriate methodology is yet to be determined at this time.

Adjusting to match macro controls

Estimates obtained from household survey data are adjusted to match the aggregate control total. These aggregate totals are obtained from national income accounts. All variables for which there are aggregate controls available are adjusted, with adjustments for individual consumption components (health, education, housing, tobacco, alcohol, other) calculated separately.

Indirect taxes

Estimates are assumed to be presented in basic prices, and thus net of indirect taxes. Only private education and other expenditures (including alcohol and tobacco) are subject to indirect taxes on consumption. In these cases, indirect taxes associated with consumption of these goods are assumed to follow the same distribution of their consumption. Adjustments are made to aggregate totals, which are calculated net of indirect taxes and results presented in basic prices. Further information on the treatment of indirect taxes can be found on the webpage for Aggregate Controls.

Uploading data to NTA website

The final step of the process is to upload your estimates to the NTA website. Directions for uploading data can be found at: Upload data

The age-specific data template, which is to be used for uploading consumption estimates, can be found at: Age-specific data template

Author: Comfort Sumida
Last Revised: September 25, 2006