Taiwan Health Estimates (Cubic Method)

Data on health expenditures, in the case of the *Family Income and Expenditure Survey* (FIES) Taiwan, was provided at the household level. To allocate these expenditures to individual members, several methods were implemented and evaluated for effectiveness. 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

$$H_j = \sum_i \sum_k P^k X_{ij}^k \,. \tag{1.1}$$

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 X_{ij}^I and number of outpatient visits X_{ij}^O) 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. [1]

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:

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

[1] This same methodology was used on the unallocated portion of household National Health Insurance (NHI) benefits.

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

$$H_j = \alpha_0^I \sum_i X_{ij}^I + \alpha_1^I age_i \sum_i X_{ij}^I + \alpha_2^I age_i^2 \sum_i X_{ij}^I + \alpha_3^I age_i^3 \sum_i X_{ij}^I + \alpha_4^I age0_i \sum_i X_{ij}^I + \alpha_0^O \sum_i X_{ij}^O + \alpha_1^O age_i \sum_i X_{ij}^O + \alpha_2^O age_i^2 \sum_i X_{ij}^O + \alpha_3^O age_i^3 \sum_i X_{ij}^O + \alpha_4^O age0_i \sum_i X_{ij}^O \quad (1.6)$$

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:

$$CFH_{ij}^* = \alpha_0^I X_{ij}^I + \alpha_1^I age_i X_{ij}^I + \alpha_2^I age_i^2 X_{ij}^I + \alpha_3^I age_i^3 X_{ij}^I + \alpha_4^I age0_i X_{ij}^I + \alpha_0^O X_{ij}^O + \alpha_1^O age_i X_{ij}^O + \alpha_2^O age_i^2 X_{ij}^O + \alpha_3^O age_i^3 X_{ij}^O + \alpha_4^O age0_i X_{ij}^O \quad (1.7)$$

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

$$CFH_{ij} = CFH_j \frac{CFH_{ij}^*}{\sum_i CFH_{ij}^*} \quad (1.8)$$

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.

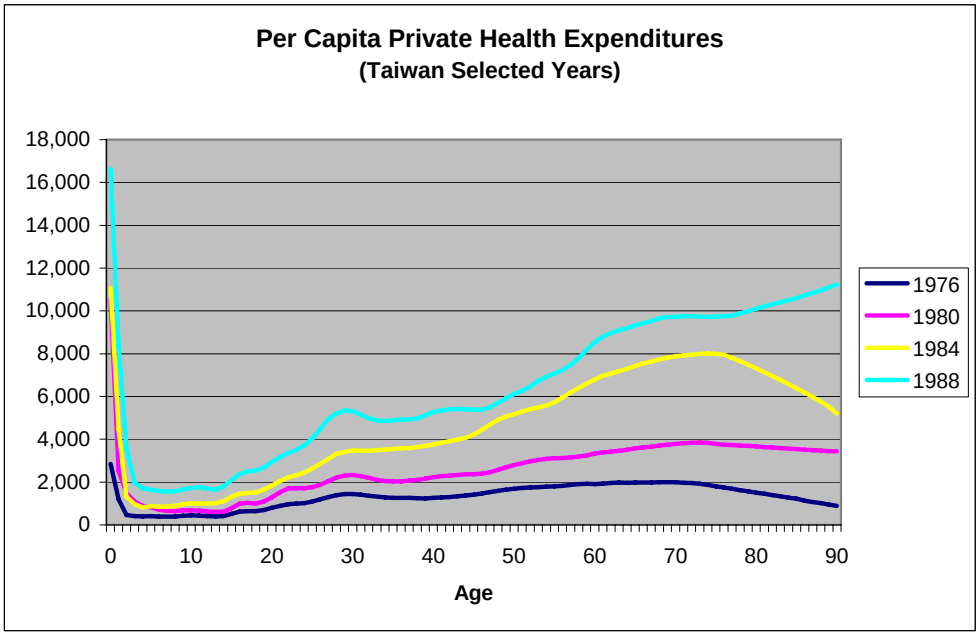
However, for years 1994 and prior, individual health usage data is not available. Thus, for these earlier years, we assume individual health usage follows the per capita

smoothed profile for 1996. Health usage is assigned to individuals based on age, and is equal the mean by age from the 1996 FIES.[2]

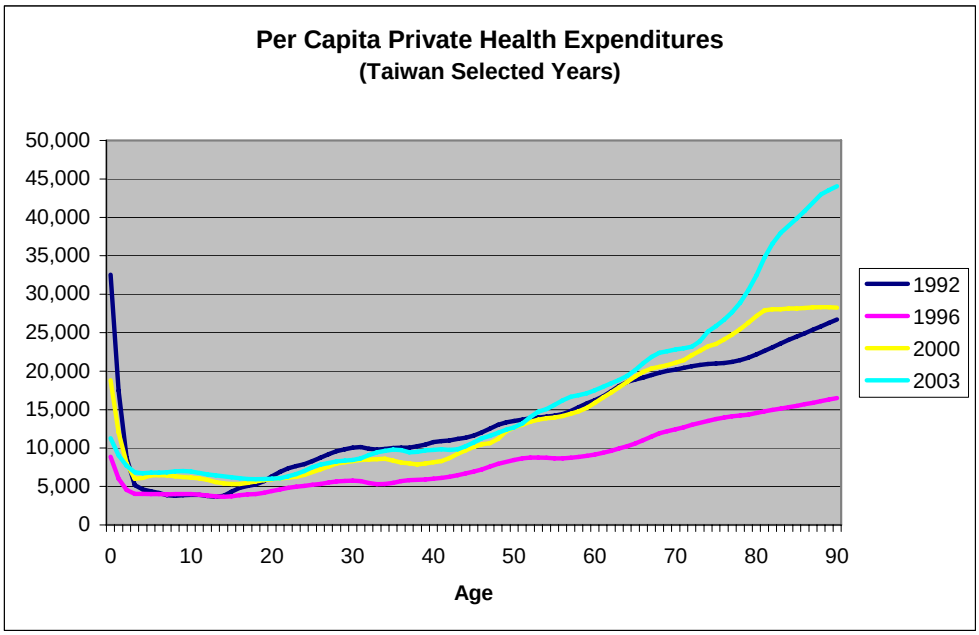
$$O_i^t(age) = \overline{O^{1996}}(age) \tag{1.9}$$

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

Results for selected years are presented in the figures below.



[2] 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.

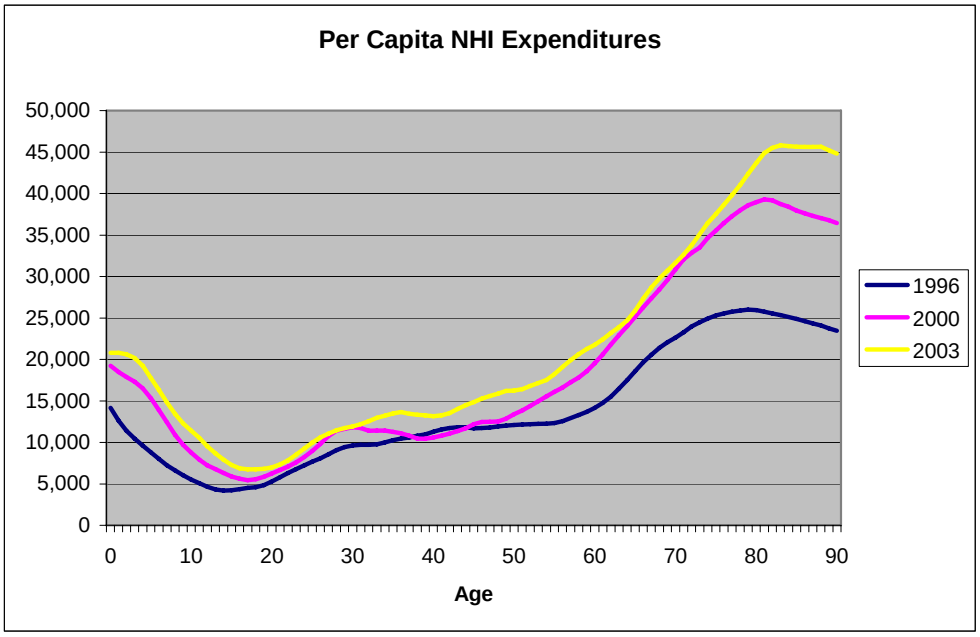


Per capita health expenditures increase over time, and are particularly high for those aged 0 and the elderly. In older profiles (those preceding NHI implementation in 1995), health expenditures for infants are relatively high, and exceed the per capita expenditures of all other age groups. Profile shapes for more recent years appear to differ from previous years. Health expenditures in more recent years are particularly high for the elderly.

The difference in profile shapes may reflect the methodology being used. It is certainly possible the profiles from 1996 do not accurately represent the health usage of Taiwan households in prior years. Implementation of NHI coverage is likely to change the way recipients view health care and their utilization of health services. NHI does not cover all segments of the population equally. Routine health care for infants is completely covered, while older individuals pay a co-payment which varies depending on the severity of illness and type of medical care sought. Thus, implementation of NHI likely

increased the use of health care by the youngest of children. Furthermore, it may have had an effect on prenatal care, and increased care provided to newborns.

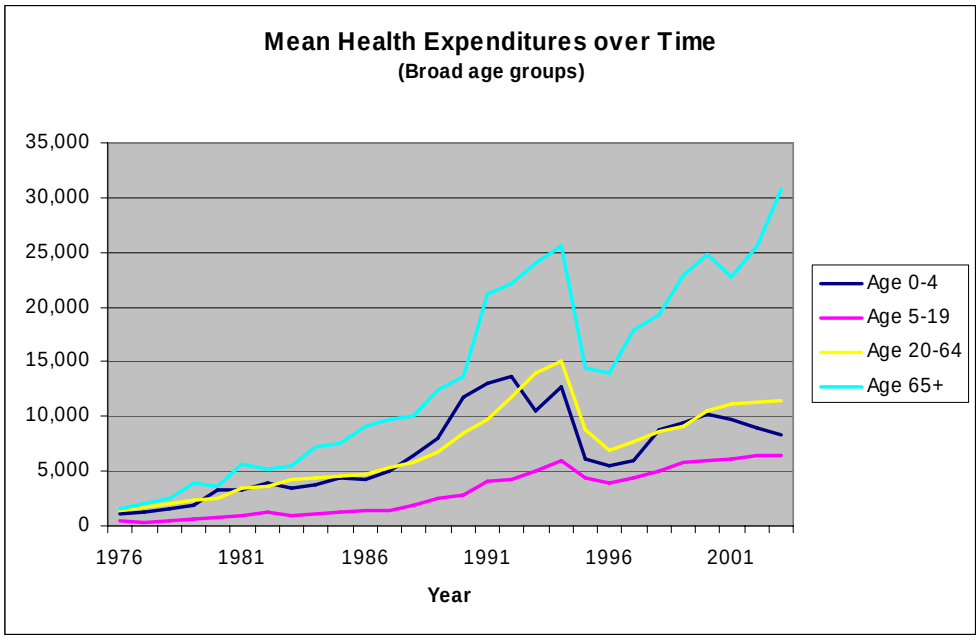
NHI covers the bulk of expenditures on prenatal and infant care and baby deliveries. Co-payments are not required for those under the age of three, and dependent premiums are capped at three children. Thus, the expenditures by households on health care for children in the household are lower. However, on average, NHI expenditures are greatest for the elderly.



Plotting the mean private health expenditures over time also indicates significant changes once NHI is implemented. NHI appears to decrease health private expenditures for all age groups, as households now rely on NHI coverage to finance a portion of their medical care. However, household health expenditures continue to increase after NHI. This may

reflect the rising cost of health care, or households may be seeking health care more often, due to better awareness and increased availability.

Comment: Changes in prices per health care unit by age over time?



Including other variables may prove helpful, and is determined on a country by country basis. For example, in the case of Taiwan, price was originally assumed to follow a quadratic in age. However, after estimation, it was found that greater flexibility was needed, and a cubic term and age 0 dummies were introduced. Behavior of estimated health expenditures at the oldest ages were also a concern, so a cubic spline for those over 75 was experimented with, but deemed unnecessary and not included in the final specification.

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