Deriving Individual Consumption From Household Data

The *FIES* data provide information on the number of members in the households surveyed and on total household purchases of various foods. The data do not provide information about how much each person in the household consumes. One way to estimate consumption per person would be to divide each household's purchases by the number of people in the household (referred to as "simple division"). Another way would be to use additional information to estimate consumption by individuals of different ages.

To illustrate these two approaches, assume that a three-person household headed by an adult in his/her mid-twenties (age 25) consumed 30 kg of some food, a four-person household headed by a middle-aged adult in his/her late forties (age 47) consumed 60 kg of food, and a three-person household headed by an old adult in his/her mid-sixties (age 65) consumed 80 kg of food.

One could estimate individual consumption by simply dividing household consumption by the number of persons in the household and assigning the result as individual consumption by an individual with the age of the household head. For example, consumption by the young adult age 25 should be 30/3 = 10 kg; consumption by an adult age 47 should be 60/4 = 15 kg; and consumption by an older adult age 65 should be 80/3 = 26.7 kg. However, these results do not take into consideration the age variation among household members.

To show how information about the ages of household members can be used to estimate consumption, consider the households used in the previous example. The first household may comprise two young adults and one infant, the second two adults in their forties and two young adults around age 20, and the third two older adults in their sixties and one adult in his/her thirties (e.g., age 32). Then, the analysis will have a set of equations as follows:

$$2X_{25} + 1\,X_{0} = 30 \qquad (1)$$

$$2X_{47} + 2\,X_{20} = 60 \qquad (2)$$

$$2X_{65} + 1\,X_{32} = 80 \qquad (3)$$

where X_i denotes individual consumption by a person i years of age.

The three equations have six unknowns, making it impossible to find a solution. If it can be assumed, however, that infants do not consume this product: $X_0 = 0$; people in their twenties and early thirties eat, on average, about the same amount: $X_{20} = X_{25} = X_{32}$, then one will have the following solutions:

$2X_{25} = 30 \rightarrow X_{25} = 15$ (vs. 10 by simple division)

$2X_{47} + 2 \times 15 = 60 \rightarrow X_{47} = (60-30)/2 = 15$ (vs. 15 by simple division)

$2X_{65} + 15 = 80 \rightarrow X_{65} = (80-15)/2 = 32.5$ (vs. 26.7 by simple division)

The simple division approach implicitly assumes that all members of the household are in the same age group as the HH, or, in an extreme example,

that infants eat as much as their parents. The *FIES* panel data of nearly 96,000 households each year provide complete details on the age composition by HH age groups of the households surveyed.[8]

Using simple supporting constraints such as $X_0 = 0$, $X_{20} = X_{25} = X_{32}$, as above, one can obtain more realistic estimates of individual consumption by age from household data than from the simple division approach.

With respect to the supporting constraints, the analysis uses the intuitively natural assumptions of gradual changes between successive age groups (i.e., the difference in consumption between individuals a year apart in age will be approximately zero ($X_i - X_{i+1} \approx 0$), which cover the entire range of age groups, instead of arbitrary *a priori* assumptions, such as $X_0 \approx 0$, $X_{17} \approx X_{22}$, or $X_7 \approx 0.6\, X_{12}$).[9] Individual consumption by age is estimated, minimizing the sum of squared residuals (4) and (5) below.[10]

$$H_j - \sum C_{ij} X_i = E_j \quad (i = 1\text{-}16\ ;\ j = 1\text{-}10) \qquad (4)$$

$$X_k - X_{k+1} = E_k \quad (k = 1\text{-}15) \qquad (5)$$

where

H_j : consumption by household headed by someone j years of age

C_{ij} : number of individuals of i years of age in household with HH j years of age

X_i : estimated consumption by individuals of i years of age

X_k : estimated consumption by individuals of k years of age

E_j, E_k : residuals

Table 4 provides estimates of annual individual consumption of oranges by age for the period 1987-2006. The estimates clearly demonstrate that individual consumption of oranges varies substantially by age throughout the survey period: generally, older people eat more oranges than younger people.[11] This effect has intensified over the period. In the late 1980s, individuals in their late thirties and older ate twice as many oranges as those in their twenties and younger, but by the middle of the 2000s, individuals in their late thirties through early fifties decreased their consumption more than 50 percent, whereas those in their late sixties and older kept their consumption at the earlier levels. Also, most strikingly, children under age 20 have reduced their consumption to one-tenth the level of people in their late sixties and older in recent years. Note that those in their forties in 2005, for example, were young adults in their twenties in the mid-1980s, those in their thirties in the mid-2000s were teenagers in the mid-1980s, and so on: everyone ages as time passes. Accordingly, this analysis uses an age/period/cohort (A/P/C) model to separate estimated individual consumption by age into age, period, and generational cohort effects.

[8]These data are not usually available to the public but were made available for this study. The actual family age compositions by HH age groups are made public only partially in *FIES* annual reports, and, if then, on a sporadic basis. The data are much more complex than that illustrated in the example, and thus, may require difficult supporting constraints.

[9]Hendrickson et al., 2001, pp. 107-08.

[10]Mori and Inaba, 1997; Tanaka et al., 2004.

[11]Estimates for younger age groups, the early twenties and the late twenties in particular, are less stable or less dependable than those for older age groups above the thirties because the HH age groups under age 25 and age 25-29 (in recent years) are small in sample size. The estimates of nonadults under age 20 are also not dependable because, unlike a married couple of two adults in the same age brackets, these individuals do not represent the principal components of age matrices of family structure by HH age groups, C_{ij}, in equation (4). Also, they are more prone to be subject to the supporting constraints of gradual changes between successive age groups (i.e., $X_{17} - X_{22} \approx 0$, $X_{12} - X_{17} \approx 0$, etc.) in deriving individual consumption from the household data organized by HH age groups.

Table 4

Estimates of average individual consumption of fresh oranges in Japan, by age

	Age of consumers (in years)							
	0~4	5~9	10~14	15~19	20~24	25~29	30~34	35~39
	Grams/person/year							
1987	243	372	450	477	472	469	797	1,086
1988	277	390	448	398	381	403	526	1,128
1989	261	342	422	467	502	534	736	776
1990	197	340	486	534	477	439	634	861
1991	121	190	247	255	242	253	383	505
1992	225	361	514	577	594	563	594	813
1993	193	328	486	524	471	471	562	846
1994	104	181	304	414	489	535	597	803
1995	206	301	422	493	510	523	589	774
1996	165	247	337	382	384	392	471	869
1997	136	215	302	338	344	398	542	711
1998	60	112	169	212	265	336	425	778
1999	25	66	105	123	131	155	285	456
2000	139	183	238	278	317	356	410	497
2001	56	108	151	166	170	199	343	493
2002	25	47	87	134	187	243	305	389
2003	108	133	175	217	261	301	316	369
2004	17	53	108	156	192	221	278	375
2005	120	129	157	211	285	344	348	367
2006	7	45	84	126	163	199	326	447

	Age of consumers (in years)							
	40~44	45~49	50~54	55~59	60~64	65~69	70~74	75 & older
	Grams/person/year							
1987	1,124	1,210	1,272	1,167	1,163	1,265	1,281	1,207
1988	1,083	988	977	986	1,036	1,056	1,031	936
1989	935	1,016	1,139	1,150	1,035	1,083	1,080	999
1990	1,166	1,268	1,245	1,146	1,202	1,161	1,097	996
1991	623	685	754	765	895	927	915	862
1992	1,133	1,185	1,269	1,157	1,125	1,223	1,238	1,180
1993	1,188	1,281	1,191	1,314	1,390	1,401	1,370	1,281
1994	1,325	1,449	1,516	1,533	1,510	1,581	1,623	1,565
1995	968	1,146	1,217	1,260	1,591	1,716	1,777	1,746
1996	950	1,046	1,028	1,035	1,134	1,354	1,410	1,387
1997	945	1,086	1,147	1,375	1,510	1,601	1,649	1,619
1998	846	931	1,020	1,213	1,332	1,402	1,435	1,406
1999	510	551	558	603	609	617	624	609
2000	609	715	815	910	1,011	1,161	1,325	1,341
2001	627	732	817	910	1,020	1,168	1,318	1,342
2002	496	609	727	849	975	1,090	1,185	1,192
2003	459	553	648	742	847	1,071	1,336	1,392
2004	514	626	724	784	831	929	1,063	1,117
2005	411	505	639	735	821	940	1,082	1,139
2006	552	684	826	880	902	1,004	1,171	1,237

~ means younger than or equal to, before a number, and older than or equal to, after a number.

Source: USDA, Economic Research Service, using Tanaka et al. model with *FIES* household data.