

## Appendix 1 Estimation formula

The estimation formula used in tabulation is as follows:

$$\bar{x} = \frac{\sum_i \sum_j \beta'_{ij} x'_{ij} + \sum_i \sum_j \beta''_{ij} x''_{ij}}{\sum_i \sum_j \beta'_{ij} + \sum_i \sum_j \beta''_{ij}}$$

where;

$x'_{ij}$ : Value of each item for the  $j$ -th tabulated household in the  $i$ -municipality of the National Survey of Family Income and Expenditure 2009 (limited one-person households). However, income or expenditures obtained by “family account book” are weighted averages with monthly adjusted adjustment coefficients.

$x''_{ij}$ : Value of each item for the  $j$ -th tabulated household in the  $i$ -municipality of the National Income and Expenditure Survey for one-person households. However, income or expenditures obtained by “family account book” are weighted averages with monthly adjusted adjustment coefficients.

$\beta'_{ij}$ : Multiplication rate used in tabulation for the  $j$ -th tabulated household in the  $i$ -municipality of the National Survey of Family Income and Expenditure 2009 (limited one-person households) for integrated tabulation

$$\beta'_{ij} = D'_{q'h} \times \sum_{m \in B'} (\tilde{\alpha}'_{im} \times M_{ijm})$$

where;

$D'_{q'h}$  : Correction coefficient by  $q'$ -area,  $h$ -sex and age group

$q'$  : 6 districts by area (Hokkaido and Tohoku, Kanto, Hokuriku and Tokai, Kinki, Chugoku, Shikoku, Kyushu, Okinawa)

$h$  : 6 group by sex and age (under 35 years, 35 ~ 59, 60 years and over)

$\tilde{\alpha}'_{im}$  : Adjusted adjustment coefficient for the  $i$ -municipality in  $m$ -month

$M_{ijm}$  : Existence of the questionnaires eligible for tabulation for the  $j$ -th tabulated household in the  $i$ -municipality in  $m$ -month (1 or 0)

$B'$  : The set of  $m$ -month ( $\{1, 2\}$ ,  $\{1\}$  or  $\{2\}$ )

As questionnaires used to tabulate and main tabulated items depend on the statistical tables, weights vary from the number of survey month, existence of the questionnaires or the number of tabulated households.

$\beta''_{ij}$ : Multiplication rate used in tabulation for household  $j$  in municipality  $i$  in the National Income and Expenditure Survey for one-person households for integrated tabulation

$$\beta''_{ij} = D''_{q'h} \times \sum_{m \in B''} (\tilde{\alpha}''_{im} \times M''_{ijm})$$

where;

$D_{q'h}$  : Correction coefficient by  $q'$ -area,  $h$ -sex and age group

$q'$  : 6 districts by area (Hokkaido and Tohoku, Kanto, Hokuriku and Tokai, Kinki, Chugoku, Shikoku, Kyushu, Okinawa)

$h$  : 6 group by sex and age (under 35 years, 35 ~ 59, 60 years and over)

$\tilde{\alpha}'_{im}$  : Adjusted adjustment coefficient for the  $i$ -municipality in  $m$ -month

$M_{ijm}$  : Existence of the questionnaires eligible for tabulation for the  $j$ -th tabulated household in the  $i$ -municipality in  $m$ -month (1 or 0)

$B'$  : The set of  $m$ -month ( $\{1, 2, \dots\}$ ,  $\{1\}$  or  $\{2\}$ )

As questionnaires used to tabulate and main tabulated items depend on the statistical tables, weights vary from the number of survey month, existence of the questionnaires or the number of tabulated households.

[Calculation of  $\tilde{\alpha}'_{im}$ , an adjusted correction coefficient, used in the National Survey of Family Income and Expenditure 2009 (limited one-person households)]

Each prefecture is divided into major cities and other areas, and adjustment coefficients are given to sample municipalities in each area.

Major cities • • • Designated cities under article 252-19 of the Local Autonomy Law (Sapporo-shi, Sendai-shi, Saitama-shi, Chiba-shi, Yokohama-shi, Kawasaki-shi, Niigata-shi, Shizuoka-shi, Hamamatsu-shi, Nagoya-shi, Kyoto-shi, Osaka-shi, Sakai-shi, Kobe-shi, Hiroshima-shi, Kitakyushu-shi, Fukuoka-shi) and Ku-area of Tokyo

$$\alpha'_i = \frac{N_D}{\sum_{d' \in D'} N_{d'}} \times \frac{N_i}{n_i}$$

$D$ : Major cities or other areas in each prefecture (However, each major cities are treated separately if prefectures have several major cities.)

$$\tilde{\alpha}'_{im} = \begin{cases} \alpha'_i \frac{n_i}{\tilde{n}_{im}} & \left( \frac{n_i}{\tilde{n}_{im}} \leq 2 \right) \\ 2\alpha'_i & \left( \frac{n_i}{\tilde{n}_{im}} > 2 \right) \end{cases}$$

- $D'$  : Sample municipalities in  $D$ -area
- $i$  : Sample municipalities
- $\alpha'_i$  : Adjustment coefficient in the  $i$ -municipality
- $N_D$  : The number of eligible households in the  $D$ -area(the 2005 Population Census)
- $N_{d'}$  : The number of eligible households in the  $d'$ -municipality  
(the 2005 Population Census)
- $N_i$  : The number of eligible households in the  $i$ -municipality  
(the 2005 Population Census)
- $n_i$  : The number of planned sample households in the  $i$ -municipality
- $\tilde{n}_{im}$  : The number of households for tabulation in the  $i$ -municipality in m-month

[Calculation of  $D'_{q'h}$ , a correction coefficient of household distribution, used in the National Survey of Family Income and Expenditure 2009 (limited one-person households) for integrated tabulation]

$D_{q'h}$  is calculated using the number of one-person households by area, sex and age groups based on the results of the 2009 Labour Force Survey. The calculation method is different between one-person householders aged below 60 and those aged 60 or over because the National Income and Expenditure Survey for one-person households covers one-person householders aged below 60 only.

One-person householders aged under 60

$$D'_{q'h} = D_{q'h} \times 0.5$$

One-person householders aged 60 or over

$$D'_{q'h} = D_{q'h}$$

$D'_{q'h}$ : Correction coefficient of household distribution used in the National Survey of Family Income and Expenditure 2009 (limited one-person households)

[Calculation of  $D_{q'h}$ , a correction coefficient of household distribution, used in the National Survey of Family Income and Expenditure 2009 (limited one-person households)]

Correction coefficient of one-person household distribution is calculated from the average number of one-person households by district, sex and age groups in the Labour Force Survey 2009.

$$D_{q'h} = \frac{W'_{q'h}}{\sum_{(i,j) \in H_{q'h}} \sum_{m \in B'} (\tilde{\alpha}'_{im} \times M_{ijm}) \times \frac{1}{|B'|}}$$

$W'_{q'h}$  : The number of one-person households by  $q'$ -area,  $h'$ -sex/age group based on the results of the 2009 Labour Force Survey

$H_{q'h}$  : The set of households which belong to  $q'$ -area and  $h$ -sex/age group

$|B'|$  : The number of survey months (Number of elements in  $B'$ )

[Calculation of  $\tilde{\alpha}''_{im}$ , a correction coefficient of household distribution, used in the National Income and Expenditure Survey for one-person households]

$$\tilde{\alpha}''_{im} = \frac{V_{ql}}{\sum_{(i,j) \in L_{ql}} \tilde{n}''_{im}}$$

$V_{ql}$ : The number of one-person households by  $q'$ -area,  $l'$ -sex/age group based on the results of the 2005 Population Census

$q$ , District group: Hokkaido, Tohoku, Kanto, Hokuriku, Tokai, Kinki, Chugoku, Shikoku, Kyushu and Okinawa (10 groups)

$l$ , sex/age group:

Men: Aged below 30, 30 to 39, 40 to 49, and 50 to 59

Women: Aged below 30, 30 to 39, 40 to 49, and 50 to 59 (eight groups)

$L_{ql}$ : The set of households which belong to  $q'$ -area and  $l'$ -sex/age group

$\tilde{n}''_{im}$  : The number of households for tabulation in the  $i$ -municipality in  $m$ -month

[Calculation of  $D''_{q'h}$ , a correction coefficient of household distribution, used in the National Survey of One-person Household Income and Expenditures for integrated tabulation]

$$D''_{q'h} = \frac{W'_{q'h}}{\sum_{(i,j) \in H''_{q'h}} \sum_{m \in B''} (\tilde{\alpha}''_{im} \times M''_{ijm}) \times \frac{1}{|B''|}} \times 0.5$$

$W'_{q'h}$  : The number of one-person households by  $q'$ -area,  $h'$ -sex/age group based on the results of the 2009 Labour Force Survey

$H_{q'h}$  : The set of households which belong to  $q'$ -area and  $h$ -sex/age group

$B''$  : The number of survey months (Number of elements in  $B''$ )