Chapter 5 Method of index calculation and the index grouping

1 Index formula

The index is calculated as the weighted arithmetic mean with a fixed basket in the base period preceding the comparison period (Laspeyres formula).

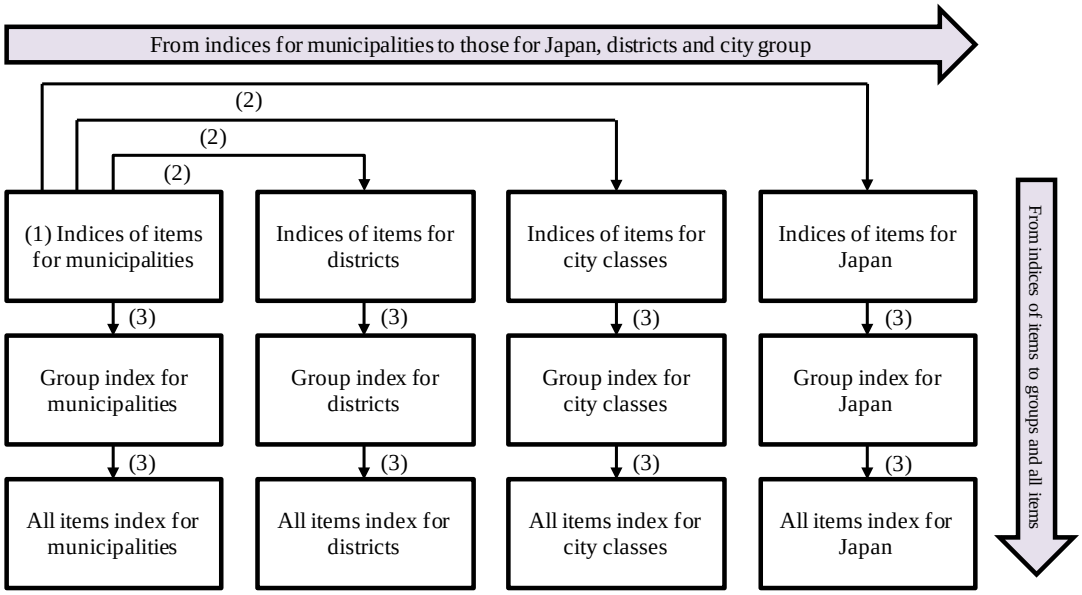
$$I_t = \frac{\sum_{i=1}\sum_{j=1} p_{t,i,j} q_{0,i,j}}{\sum_{i=1}\sum_{j=1} p_{0,i,j} q_{0,i,j}} \times 100 = \frac{\sum_{i=1}\sum_{j=1} \frac{p_{t,i,j}}{p_{0,i,j}} w_{0,i,j}}{\sum_{i=1}\sum_{j=1} w_{0,i,j}} \times 100$$

I: Index, *p*: Price, *q*: Quantity, *w*: Weight (= *pq*), *i*: Item, *j*: Municipalities,
0: Base period, *t*: Comparison period

2 Process of the index calculation

The process of index calculation is as follows: Firstly, indices of items for municipality are calculated, followed by indices of items for Japan and for districts and city groups. Finally, indices for upper level groups and all items index are calculated for each area.

During the process of the calculation of indices, they are not rounded. In the statistical tables, figures are rounded off to one decimal place.



(1) Calculation of indices of items for municipalities

Indices of items are calculated by dividing the price in the comparison period by the price in the base period for each municipality.

(2) Calculation of indices of items for districts, city groups and Japan

Indices of items for each municipality are averaged with the respective weights for each municipality to obtain the indices of items for districts, city groups and Japan.

(3) Calculation of group index and all items index

Indices of items for Japan, districts, city groups and municipalities are averaged with weights by item to obtain group indices, which are averaged with weights by group in sequence to obtain all items index.

When calculating the group indices for fresh food, the monthly weights are used for the weights of items.

3 Processing of items for which prices in the comparison period are missing

When an item temporarily disappears from the market in a surveyed municipality, and the price of that item in the comparison period is inevitably "missing," the index of that item, which cannot be calculated due to the "missing" price in the comparison period," and the weight of that item are excluded from calculation..

When the item is aggregated to a group, its price movement is substituted by the group index calculated from other items in the group.[20]

In the calculation of indices from lower level groups to upper level group, group weights including the weight of the item whose price is missing are used to avoid the fluctuation of each group weight.

4 Calculation of average indices for calendar year, fiscal year and so on

(1) Average indices for calendar year

Average indices for calendar year are calculated as the simple arithmetic means of monthly indices (figures before rounding of fractions) from January to December for each item and group. As for items of fresh food, indices are calculated as weighted arithmetic means by monthly weights. In the statistical tables, figures are rounded off to one decimal place.

(2) Average indices for fiscal year

Average indices for fiscal year are calculated by using monthly indices from April to March the following year, in the same manner to find the average indices for calendar year.

(3) Quarterly average indices

Quarterly average indices are calculated for periods from January to March, April to June, July to September, and October to December in the same manner to find the yearly average indices.

[20] Indices for Japan, districts and city groups are calculated after the calculation of indices of items. As a result, the price movement of an item whose price is missing is substituted by the item price index of the corresponding area excluding the municipality in question.

5 Calculation of the rate of change

(1) Change from the previous month

Change from the previous month is calculated by item and group using the following equation:

$$\text{Change from the previous month (\%)} = \frac{I_{\text{This month}} - I_{\text{Previous month}}}{I_{\text{Previous month}}} \times 100$$

(*I*: Index)

(2) Change over the year

Change over the year is calculated by item and group, by the following equation:

$$\text{Change from the same month of the previous year (\%)} = \frac{I_{\text{This month}} - I_{\text{Same month of previous year}}}{I_{\text{Same month of previous year}}} \times 100$$

(*I*: Index)

Changes from the previous quarter and the same quarter in the previous year are calculated in the same way.

The rate of change is calculated with an index before the rounding of fractions. In the statistical tables, figures are rounded off to one decimal place.

Differences in the index and the ratio of change are indicated as “the difference of xx points.”

6 Calculation of the contribution to the total change

The contribution of the change in the index of an item or group to the change in the all items index is calculated. The sum of contribution of all items is the rate of change of all items index[21]. The calculation formula is as follows:

$$\text{Contribution of an item A to the total change} = \frac{\left(I_{\text{Item A in this period}} - I_{\text{Item A in previous period}}\right)}{I_{\text{All items in previous period}}} \times \frac{w_{\text{Item A}}}{w_{\text{All items}}} \times 100$$

(*I*: Index, *w*: Weight)

However, the contribution to total change over the year of items categorized as fresh food is calculated using the following formula:

$$\text{Contribution of an item A to the total change} = \frac{\left(I^{\text{Item A}}_{\text{in this month}} \times w^{\text{Item A}}_{\text{in this month}}\right) - \left(I^{\text{Item A in the}}_{\text{previous month}} \times w^{\text{Item A in the}}_{\text{previous month}}\right)}{I_{\text{All items in previous month}} \times w_{\text{All items}}} \times 100$$

(*I*: Index, *w*: Weight)

The contribution to total change is calculated with an index before the rounding of fractions. In the statistical tables, figures are rounded off to two decimal places.

[21] It may not be equal in the statistical tables due to the rounding of fractions

7 Index grouping

(1) Basic classification indices

Indices by basic classification, classified by the use and function of goods and services purchased by households and based on the classification by consumption expenditure in the FIES are calculated. As for the classification, refer to "IV 3 Aggregation table from the items to the groups (basic classification)."

The following indices are calculated as the analytical series to basic classification indices. They are calculated as follows:

a) Fresh food

The index of "Fresh food" is calculated by averaging group indices of "Fresh fish & seafood", "Fresh vegetables" and "Fresh fruits" with each group weight.

b) All items, less fresh food

$$\text{All items, less fresh food} = \frac{\left(I_{\text{All items}} \times w_{\text{All items}}\right) - \left(I_{\text{Fresh food}} \times w_{\text{Fresh food}}\right)}{w_{\text{All items}} - w_{\text{Fresh food}}}$$

(*I*: Index, *w*: Weight)

The index of "Food, less fresh food" is calculated by the same method.

c) All items, less imputed rent

$$\text{All items, less imputed rent} = \frac{\left(I_{\text{All items}} \times w_{\text{All items}}\right) - \left(I_{\text{Imputed rent}} \times w_{\text{Imputed rent}}\right)}{w_{\text{All items}} - w_{\text{Imputed rent}}}$$

(*I*: Index, *w*: Weight)

The index of "Housing, less imputed rent" and "Rent, less imputed rent" is calculated by the same method.

d) All items, less imputed rent and fresh food

$$\text{All items, less imputed rent and fresh food} = \frac{\left(I_{\text{All items, less imputed rent}} \times w_{\text{All items, less imputed rent}}\right) - \left(I_{\text{Fresh food}} \times w_{\text{Fresh food}}\right)}{w_{\text{All items, less imputed rent}} - w_{\text{Fresh food}}}$$

(*I*: Index, *w*: Weight)

e) Energy

The index of "Energy" is calculated by averaging indices of five items, "Electricity", "Gas, manufactured & piped", "Liquefied propane", "Kerosene" and "Gasoline" with each weight.

f) All items, less food (less alcoholic beverages) and energy

All items, less food (less alcoholic beverages) and energy

$$= \frac{\left(I_{\text{All items}} \times w_{\text{All items}}\right) - \left[\left(I_{\text{Food}} \times w_{\text{Food}}\right) - \left(I^{\text{Alcoholic}}_{\text{beverages}} \times w^{\text{Alcoholic}}_{\text{beverages}}\right)\right] - \left(I_{\text{Energy}} \times w_{\text{Energy}}\right)}{w_{\text{All items}} - \left(w_{\text{Food}} - w^{\text{Alcoholic}}_{\text{beverages}}\right) - w_{\text{Energy}}}$$

(*I*: Index, *w*: Weight)

g) Expenses for education

The index of "expenses for education" is calculated by averaging the index of each item or group in this category with the relevant weight.

h) Expenses for culture & recreation

The index of "expenses for culture & recreation" is calculated by averaging the index of each item or group in this category with the relevant each weight.

i) Expenses for information & communication

The index of "expenses for information & communication" is calculated by averaging the index of each item in this category with the relevant weight.

As shown in the table below, the basic classification indices are calculated for a total of 72 groupings including Japan, Ku-area of Tokyo and city groups[22], districts, major metropolitan areas, Cities with Prefectural Governments (excluding the Ku-area of Tokyo) and government ordinance-designated cities (Kawasaki-shi, Sagamihara-shi, Hamamatsu-shi, Sakai-shi and Kitakyushu-shi).

Grouping	Month	Quarterly (only in Japan and the Ku-area of Tokyo)	Calendar and fiscal year
All items/ 10 major group	○	○	○
Subgroup classification	○	—	○
Minor group classification (only in Japan and the Ku-area of Tokyo)	○	—	○
Item (only in Japan and the Ku-area of Tokyo)	○	—	○
Analytical series	○	○	○

[22] For classification of city groups, districts and major metropolitan areas, refer to "IV 2 List of municipalities for price survey."

(2) Goods and services group indices

After classifying items into goods or services, goods and services group indices, segmentalized by using industrial classification as a reference, are calculated. As for the classification, refer to "IV 4 Aggregation table from the items to the groups (goods and services group)."

Goods and services group indices are calculated by averaging the price indices of items in a group classified by goods and services group with relevant weights for each item. Indices of item, weights and formulas used for calculating indices are the same as those for the basic classification.

The analytical series[23] is also calculated by averaging with the weight of a relevant items and groups according to their categories.

Index by monthly, quarterly average, calendar yearly average and fiscal yearly average are calculated for Japan and Ku-area of Tokyo.

(3) Indices aggregated based on baskets of specific household groups

The CPI measures the price movement of goods and services purchased by households having average consumption patterns, but in practical terms, the consumption pattern varies depending on the income and the age of the head of household, which are closely related to consumption activities. The effect of price fluctuation could also vary.

Therefore, the indices listed below are provided based on the baskets of specific household groups.

Price indices by item for Japan are used in common to calculate the index by specific household group while the weight is created for each basket of specific household groups[24].Therefore, differences in indices calculated based on baskets of specific household groups result from the difference of item weights by specific household groups, i.e. the difference in the pattern of living expenditure.

a) Subgroup Index for Total Households.....monthly and annually

b) Subgroup Index by Yearly Income Quintile Group[25] of Worker's Households
.....monthly and annually

c) Subgroup Index for Retired Elderly Households (age 60 and over / 65 and over)
.....monthly and annually

d) 10 Major Group Index by Age Group[26]of Household Head.....annually[27]

e) 10 Major Group Index by Type of Tenure of Dwelling[28].....annually

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[23] Of the reference indices, "Public utilities charges" includes the prices (1) determined by the diet or government, (2) approved or permitted by the government, and (3) determined by the local government. The classification of durable goods, semi-durable goods and non-durable goods is in accordance with the goods and services classification in FIES.

[24] As for fresh food, the monthly weights are calculated using quantity ratios to the yearly average, which are obtained in the calculation of indices for the basic classification.

[25] Quintile group: first group (~ ¥4.39 million), second group (¥4.39 ~ 5.76 million), third group (¥5.76 ~ 7.20 million), fourth group (¥7.20 ~ 9.13 million) and fifth group (¥9.13 million ~).

[26] Age group: less than 29, 30 ~ 39, 40 ~ 49, 50 ~ 59, 60 ~ 69 and 70 and older.

[27] The annual indexes for d) and e) are calculated using annual index by item.

[28] Type of tenure of dwelling: Own housing, private rent housing, public rent housing and company house

(4) Indices by the characteristics of items

a) Indices by goods group classified according to the elasticity to living expenditure

Categorizing each item by expenditure elasticity[29] obtained from the FIES, the indices by goods groups classified according to elasticity of consumption expenditure is calculated.

<<Expenditure elasticity>>

Less than 1.....Item classified as basic expenditure

1 and over.....Item classified as selective expenditure

b) Indices of annual purchase frequency classes

Items are classified based on the annual purchase frequency per household[30] obtained from the FIES, and indices are calculated by the class of purchase frequency.

<<Purchase frequency class>>

Items seldom purchased.....Less than 0.5 times a year

Items purchased about once a year.....0.5 to 1.5 times a year

Items purchased about once every six months.....1.5 to 4.5 times a year

Items purchased about once every two months.....4.5 to 9.0 times a year

Items purchased about once a month.....9.0 to 15.0 times a year

Items frequently purchased .....15.0 times or more a year

The indices of a) and b) are calculated for Japan as shown in the following table:

Grouping	Monthly	Yearly
All items, less imputed rent	○	○

(5) Indices calculated by Laspeyres' Chain Index (reference indices)

The chain-linking method is to calculate the index ("link index") of a period referred tothe period immediately before that period and finds the index ("chain index") by multiplying the link indices of two consecutive periods.

Monthly and yearly average indices are calculated throughout Japan in this method. For details, refer to "III Appendix 4 Calculation of the CPI by Laspeyres' Chain Index method."

[29] Expenditure elasticity is calculated using a regression method based on the total monthly expenditure and amounts of individual expenditure items per household by income classes of households composed of two or more persons obtained from the FIES in 2011 to 2013.For details of calculation, refer to http://www.stat.go.jp/data/kakei/kou27/dan27.htm (in Japanese only)

[30] Similar to expenditures, annual purchase frequency is also indicated with the average of expenditure frequency of the households including those which do not buy the target items in the FIES. Therefore, the expenditure frequency for the item such as "private house rent" is averaged using the households which pay the rent once a month and those which do not. As a result, the annual purchase frequency is smaller than the averaging among those paid in some cases. When the association between the FIES items and CPI items is not 1:1, the annual purchase frequency of FIES items is distributed to the CPI items in the similar way used for calculating the weight.

[Remark] Disclosure of indices with fractions up to three decimal digits

Indices for Japan having three decimal places are presented for reference (indices for basic classification items, and indices for goods and services group).

Indices having three decimal places are only the reference values for the user of CPI results for calculation. It does not mean that the accuracy of index values increases with the fractions of three decimal places. The formal indication of numerical values such as indices and the rate of change are kept up to one decimal place as before. Using figures containing fractions up to three decimal places, the consistency between the contribution of groups and items and the rate of change of all items index, and the reproducibility of the rate changes from the published indices would increase, but it should be noted that a complete reproducibility is not always achievable.