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Method for Estimating the 2025-base Total Consumption Trend Index (CTI macro)

1. Outline of the Total Consumption Trend Index (CTI macro)

The Total Consumption Trend Index (CTI macro) is an index that expresses total consumption expenditure by all households in Japan relative to the average monthly expenditure in the base year, which is set equal to 100.

2. Release of the Total Consumption Trend Index (CTI macro)

(1) Series released

The following series of the Total Consumption Trend Index (CTI macro) are released monthly:

- Nominal index: an index estimated based on actual market prices
- Real index: an index estimated after adjusting for the effects of price changes
- Trend-cycle estimate: an index obtained by removing irregular fluctuations from the real index

For both the nominal and real indices, two series are released: one for which seasonally adjusted Household Final Consumption Expenditure in the GDP statistics is used as the dependent variable, and another for which seasonally adjusted Household Final Consumption Expenditure excluding imputed rent is used as the dependent variable. The latter series was introduced with the 2025-base revision.

The seasonal component is removed at the estimation stage for all series. Therefore, no distinction is made between original and seasonally adjusted series. The monthly values are subject to retrospective revision whenever results for the latest month are released.

(2) Release schedule

The monthly results of the Total Consumption Trend Index (CTI macro) are released around the beginning of the second month following the reference month, at the same time as the results of the Family Income and Expenditure Survey.

3. Estimation Method for the Total Consumption Trend Index (CTI macro)

(1) Selection of official statistics underlying the explanatory-variable series

Official statistics used as the basis for the explanatory-variable series were selected on the basis of the Akaike Information Criterion (AIC), with seasonally adjusted Household Final Consumption Expenditure in the GDP statistics used as the dependent variable. The following three official statistics are currently used for each of the nominal and real indices.

The same explanatory-variable series are also used for the series for which seasonally adjusted Household Final Consumption Expenditure excluding imputed rent in the GDP statistics is used as the dependent variable.

a. Nominal index

- Household Consumption Trend Index (CTI micro), original series (nominal index) for total households, consumption expenditure (Statistics Bureau, Ministry of Internal Affairs and Communications)
- Preliminary Report on the Current Survey of Commerce, original value, retail (sales value) (Ministry of Economy, Trade and Industry)
- Monthly Business Survey of Services, service industry (sales) (Statistics Bureau, Ministry of Internal Affairs and Communications)*

* For the period before October 2008, when the Monthly Survey on Service Industries, the predecessor of the Monthly Business Survey of Services, was launched, predicted values obtained from a time-series regression model using the Indices of Tertiary Industry Activity as an explanatory variable are used.

b. Real index*

- Household Consumption Trend Index (CTI micro), original series (real index) for total households, consumption expenditure (Statistics Bureau, Ministry of Internal Affairs and Communications)
- Indices of Tertiary Industry Activity, original index, broad-ranging personal service (Ministry of Economy, Trade and Industry)
- Indices of industrial production, original index, consumer goods (Ministry of Economy, Trade and Industry)

* The real index is estimated using explanatory-variable series derived from official statistics, rather than by deflating the nominal index.

(2) Estimation of the explanatory-variable series

For each monthly time series ($Y_n^{Original}$) of the official statistics selected in (1), a component decomposition model commonly used in seasonal adjustment is assumed. Under this model, each series consists of a trend component (T_n), a cyclical component (C_n), a seasonal component (S_n), outlier effects representing abrupt changes (D_n^k), a leap-year component (LY_n), and an irregular component representing observation noise ($I_n = \varepsilon_n^{Original}$). These components are estimated using a state-space model. A state-space model assumes that unobservable states underlie the observed values and estimates those states from the observed values. In general, the model consists of an observation equation, or observation model, which describes how the states affect the observed values, and state equations, or system models, which describe how the states evolve over time.

In estimating the components, a linear Gaussian state-space model is used. The model assumes that each observed monthly time series of the official statistics selected in (1) is expressed as a linear combination of the respective components and that the disturbances in the model follow normal distributions with a mean of zero. No variables are included to adjust for calendar effects, except for the leap-year component, which was introduced with the 2025-base revision.

At the time of estimation, results for the reference month are not yet available for the Monthly Business Survey of Services and the Indices of Tertiary Industry Activity because of their release schedules.

Consequently, the observations for the reference month are treated as missing values. A one-step-ahead forecast based on data through the preceding month is therefore produced using the Kalman filter, an efficient algorithm for state estimation, to construct the monthly time series through the reference month.

[Observation equation]

$$Y_n^{Original} = T_n + C_n + S_n + \sum_{k=1}^{K} D_n^k + LY_n + \varepsilon_n^{Original} \qquad \varepsilon_n^{Original} \sim N\left(0, \sigma_{Original}^2\right)$$

[State equation]

$$T_n = 2T_{n-1} - T_{n-2} + \varepsilon_n^T \qquad \varepsilon_n^T \sim N(0, \sigma_T^2)$$

$$C_n = \alpha_1 C_{n-1} + \alpha_2 C_{n-2} + \varepsilon_n^C \qquad \varepsilon_n^C \sim N(0, \sigma_C^2)$$

$$S_n = -\sum_{i=1}^{11} S_{n-i} + \varepsilon_n^S \qquad \varepsilon_n^S \sim N(0, \sigma_S^2)$$

$D_n^k = \beta^k Z_n^k \ \ (k = 1,2,\cdots,K)$ (Z_n^k: Variables specifying the type of dummy)

$LY_n = \gamma l y_n$ (LY_n: a variable representing the difference in the number of days in February caused by a leap year.*)

*The value is set to 0.75 for February in a leap year, -0.25 for February in a non-leap year, and 0 for all other months

For each selected official statistical series, the explanatory-variable series (X_n^i) used in (3) is constructed by summing the trend component (T_n), the cyclical component (C_n), and the outlier effects (D_n^k) estimated using the model above. Accordingly, the seasonal component (S_n), the leap-year component (LY_n), and the irregular component ($\varepsilon_n^{Original}$) are not included in the explanatory-variable series.

For each of the nominal and real dependent variables in the GDP statistics, there are three explanatory-variable series corresponding to the three official statistics listed in (1)(a) and (b), respectively.

$$X_n^i := T_n + C_n + \sum_{k=1}^{K} D_n^k \qquad (i = 1,2,3)$$

(3) Estimation of monthly values and calculation of the Total Consumption Trend Index

Using the three explanatory-variable series estimated in (2), monthly total consumption expenditure (y_n) is estimated separately for each dependent variable by means of the time-series regression model based on the state-space model shown below.

The model uses time-varying regression coefficients (β_n^i), which change dynamically over time, thereby allowing the relationships among the variables to vary from month to month. At the end of each quarter, the second observation equation imposes the constraint that the sum of the three monthly estimates is consistent with the quarterly observed value (Y_n^{GDP}) of the relevant dependent variable in the GDP statistics.

For months in which a quarterly GDP value (Y_n^{GDP}) is not available, a one-step-ahead forecast of the monthly value (y_n) is produced using the Kalman filter.

[Observation equation]

$$y_n = T_n + \sum_{i=1}^{3} \beta_n^i X_n^i$$

$$Y_n^{GDP} = y_n + y_{n-1} + y_{n-2} + \varepsilon_n^{GDP} \qquad \varepsilon_n^{GDP} \sim N(0, \sigma_{GDP}^2)$$

[State equation]

$$T_n = 2T_{n-1} - T_{n-2} + \varepsilon_n^T \qquad \varepsilon_n^T \sim N(0, \sigma_T^2)$$

$$\beta_n^i = \beta_{n-1}^i + \varepsilon_n^{\beta^i} \quad (i = 1,2,3) \qquad \varepsilon_n^{\beta^i} \sim N\left(0, \sigma_{\beta^i}^2\right)$$

For each dependent variable, the Total Consumption Trend Index (CTI_n) is calculated by dividing the estimated monthly total consumption expenditure (y_n) by the average monthly total consumption expenditure in the base year (y_{base}) and multiplying the result by 100.

$$CTI_n := \frac{y_n}{y_{base}} \times 100$$

(4) Calculation of the trend-cycle estimate

The trend-cycle estimate is calculated by removing the irregular component from the real Total Consumption Trend Index for which seasonally adjusted Household Final Consumption Expenditure in the GDP statistics is used as the dependent variable, using the Census Method (X-12-ARIMA).

The X-12-ARIMA specifications use the same ARIMA model as that used to calculate the trend-cycle estimate for all households in the Household Consumption Trend Index (CTI micro). “Trading-day and leap-year effects” and “holiday and end-of-month weekday effects” are included as regression variables.

The monthly values are subject to retrospective revision whenever results for the latest month are released.

4. Specification of Outliers for Seasonal Adjustment

For each official statistical series underlying the explanatory-variable series selected in 3(1), the types and timing of the outlier dummy variables used in the estimation of the explanatory-variable series in 3(2) are selected on the basis of the Akaike Information Criterion (AIC). The specifications are reviewed on a monthly basis and revised as necessary in light of the accumulation of additional data. The outlier dummy variables currently specified are listed below.

(Legend) AO: additive outlier, LS: level shift, Rp: ramp

a. Nominal index

- Household Consumption Trend Index (CTI micro) (Statistics Bureau, Ministry of Internal Affairs and Communications)
  March 2011: AO, April 2011: AO, March 2014: AO, April 2014: AO, May 2014: AO,
  September 2019: AO, October 2019: LS, February - April 2020: Rp, May - October 2020: Rp,
  June 2020: AO, January 2021: AO, February 2021: AO, May 2021: LS, August 2021: AO,
  January 2022: LS, February - June 2022: Rp, August 2022: AO
- Preliminary Report on the Current Survey of Commerce (Ministry of Economy, Trade and Industry)
  March 2011: AO, April 2011: AO, May 2011: AO, March 2014: AO, April 2014: AO,
  September 2019: AO, October 2019: AO, February - April 2020: Rp, June 2020: LS,

February 2023: LS

○ Monthly Business Survey of Services (Statistics Bureau, Ministry of Internal Affairs and Communications)
February - April 2020: Rp, June 2020: LS, August - October 2020: Rp, January 2021: LS,
August 2021: AO, September - November 2021: Rp, February 2022: AO, March 2022: AO

b. Real index

○ Household Consumption Trend Index (CTI micro) (Statistics Bureau, Ministry of Internal Affairs and Communications)
March 2011: AO, April 2011: AO, March 2014: AO, April 2014: AO, May 2014: AO,
September 2019: AO, October 2019: LS, February - April 2020: Rp, May - October 2020: Rp,
June 2020: AO, January 2021: AO, February 2021: AO, May 2021: LS, August 2021: AO,
December 2021 - February 2022: Rp, August 2022: AO

○ Indices of Tertiary Industry Activity (Ministry of Economy, Trade and Industry)
March 2011: AO, April 2011: AO, May 2011: AO, March 2014: AO, April 2014: LS,
September 2019: AO, October 2019: AO, February - April 2020: Rp, June 2020: LS,
July - October 2020: Rp, January 2021: AO, May 2021: AO, August 2021: AO,
September - November 2021: Rp, January 2022: AO, February 2022: AO, March 2022: AO
February 2023: LS

○ Indices of industrial production (Ministry of Economy, Trade and Industry)
September 2008 - February 2009: Rp, March - July 2009: Rp, March 2011: AO, April 2011: AO,
May 2011: AO, October 2019: LS, March - May 2020: Rp, July 2020: LS,
July - September 2021: Rp, September - November 2021: Rp, May - August 2022: Rp

References

[1] Takabe Isao. (2018), The Consumption Trend Index (CTI): Estimation Methods for the Macro Consumption Trend, *Research Memoir of Official Statistics*, No.75, Statistical Research and Training Institute Ministry of Internal Affairs and Communications Japan, 21-40 (in Japanese).

[2] 消費統計研究会(2017年度第１回～第３回、2025年度第１回)資料
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