

Consumer Price Index: The Bank of Canada's Preferred Measures of Core Inflation

Methodology Document

Overview

The Consumer Price Index (CPI) plays a key role in the Bank of Canada's conduct of monetary policy.

In 1991, the Bank of Canada and the Government of Canada jointly established an inflation-targeting framework for the conduct of monetary policy. This framework is reviewed every five years, with the most recent renewal occurring in October 2016. Based on this framework, the Bank of Canada conducts monetary policy aimed at keeping inflation, as measured by the change in the All-items CPI, at 2 per cent, the midpoint of an inflation-control range of 1 to 3 per cent.

To help it achieve this target, the Bank of Canada uses a set of measures of core inflation. The purpose of these measures is to capture persistent price movements by eliminating transitory or sector-specific fluctuations in some components of the CPI. From 2001 until the most recent renewal of the inflation control target, the Bank of Canada's focal measure of core inflation was the All-items CPI excluding eight of its most volatile components (as defined by the Bank of Canada) as well as the effect of changes in indirect taxes on the remaining components (CPIX). For more information, see the Bank of Canada Review article (Macklem (2001)).

As discussed in the [Renewal of the Inflation-Control Target – Background Information](#), the Bank of Canada has identified three preferred measures of core inflation to help assess underlying inflation in Canada.¹ The Bank of Canada chose these three measures based primarily on analysis conducted in 2015 by its researchers ([Khan, Morel and Sabourin \(2015\)](#)). While the Bank's emphasis will be on these three measures, Statistics Canada will continue to calculate and publish CPIX.

Although no measure of core inflation was superior across all the evaluation criteria, three measures showed the best performance. Based on the results of this analysis, the Bank of Canada decided to change its approach by jointly using all three measures: i) a measure based on the trimmed mean (CPI-trim); ii) a measure based on the weighted median (CPI-median); and, iii) a measure based on the common component (CPI-common). For more information on how the three measures were chosen, see the background document on the renewal of the inflation-control target ([Bank of Canada \(2016\)](#)). In the rest of this document, we will present detailed information on the methodologies and data used to produce these measures of core inflation.²

Reference period

These measures are expressed as a year-over-year percentage change (i.e., comparing any month in a given year to the same month in the previous year). Accordingly, they are not available in the form of an index level and do not have a reference period (e.g., 2002=100).

Data sources and methodologies

The three preferred measures of core inflation are computed by Statistics Canada using data from the CPI Survey. For more information on the data sources, error detection, imputation rules, estimation and calculation of price indexes, quality evaluation of the data collected, and data disclosure control for the CPI survey, see the [description of this survey](#). Below, we will describe the CPI data used and the methods for calculating these three measures of core inflation.

The three measures require historical series of consumer price indexes based on the disaggregation of the All-items CPI into a fixed number of components. These components are exhaustive and mutually exclusive. Therefore, the sum of their respective weights in the CPI basket is equal to 100. These measures are based on a 55-component disaggregation of the CPI basket; a complete list of these components is provided in Table A1 in the appendix of this document. These historical series are available on a monthly basis. Owing to data limitations, these 55 components are calculated since January 1989.³ Since we use price indexes calculated at the national level, the three measures are only calculated at that level of detail.

The consumer price indexes of the 55 components are first adjusted to remove the effect of changes in indirect taxes.

Measure of core inflation based on the trimmed mean (CPI-trim)

CPI-trim excludes from the 55 components those whose monthly rates of change in the CPI are located in the tails of the distribution of the monthly rates of change of all the price indexes in a given month. This measure is calculated as a weighted arithmetic average of the price changes of the non-excluded components. The weight of a component corresponds to its weight in the CPI basket at the basket link month. The procedure for calculating CPI-trim every month can be described as follows.

Step 1: The historical series of price indexes for the 55 components, adjusted to remove the effect of changes in indirect taxes, are seasonally adjusted. For more information on the seasonal adjustment methodology, see the "Revisions and seasonal adjustment" section below.

Step 2: We obtain the distribution of all monthly inflation rates calculated for the 55 components based on the percentage changes in price indexes for the current month versus those for the previous month. These monthly inflation rates are then sorted in ascending order (i.e., from lowest to highest). By ranking all the components' weights and monthly inflation rates together in this order, components with the lowest inflation rates are excluded, which accounts for 20 per cent⁴ of the total CPI basket. The same process is used to exclude components with the highest inflation rates, up to 20 per cent⁵ of the basket.

Step 3: We calculate a monthly trimmed inflation rate, $\text{CPI-trim}_t^{m/m}$, defined as the weighted arithmetic average of monthly inflation rates for components not excluded in Step 2, which make up 60 per cent of the total CPI basket. The weight of the excluded components will always be 40 per cent of the total CPI basket, but the excluded components are not necessarily the same from month to month.

Step 4: We produce the annual inflation rate for a given month, $\text{CPI-trim}_t^{y/y}$, using the cumulative monthly trimmed inflation rates for the 12-month period ending in the current month. The following formula is used for this purpose:

$$\text{CPI-trim}_t^{y/y} = \left(\left(1 + \frac{\text{CPI-trim}_{t-11}^{m/m}}{100} \right) \times \left(1 + \frac{\text{CPI-trim}_{t-10}^{m/m}}{100} \right) \times \dots \times \left(1 + \frac{\text{CPI-trim}_t^{m/m}}{100} \right) - 1 \right) \times 100$$

In other words, the annual inflation rate, $\text{CPI-trim}_t^{y/y}$, measured for a given month t is calculated as the cumulative monthly trimmed inflation rates over the 12-month period ending in month t .

Measure of core inflation based on the weighted median (CPI-median)

CPI-median represents, for a given month, the price change corresponding to the 50th percentile (in terms of CPI basket weights) of the distribution of price changes of the 55 components. As with CPI-trim, the weight of a component is represented by its weight in the CPI basket at the basket link month. The method for processing data for the CPI-median is similar to that for CPI-trim. The procedure for calculating CPI-median every month can be described as follows.

Step 1: The historical series of price indexes for the 55 components, adjusted to remove the effect of changes in indirect taxes, are seasonally adjusted. For more information on the seasonal adjustment methodology, see the "Revisions and seasonal adjustment" section below.

Step 2: We obtain the distribution of all monthly inflation rates calculated for the 55 components based on the percentage changes in price indexes for the current month versus those for the previous month. These monthly inflation rates are then sorted in ascending order (i.e., from lowest to highest). By ranking all the components' weights and inflation rates together in this order, we identify the monthly inflation rate located at the 50th percentile⁶ (in terms of CPI basket weights) of the distribution of the monthly inflation rates for the 55 components. This value represents the monthly inflation rate based on the weighted median, $\text{CPI-median}_t^{m/m}$. The component corresponding to the weighted median value is not necessarily the same from month to month. This approach is similar to that for CPI-trim because it eliminates all the weighted monthly price variations at both the bottom and top of the distribution of price changes in any given month, except the price change for the component that is the midpoint of that distribution.

Step 3: We produce the annual inflation rate, $\text{CPI-median}_t^{y/y}$, for a given month, using the cumulative monthly inflation rates based on the weighted median for the 12-month period ending in the current month. The following formula is used for this purpose:

$$\text{CPI-median}_t^{y/y} = \left(\left(1 + \frac{\text{CPI-median}_{t-11}^{m/m}}{100} \right) \times \left(1 + \frac{\text{CPI-median}_{t-10}^{m/m}}{100} \right) \times \dots \times \left(1 + \frac{\text{CPI-median}_t^{m/m}}{100} \right) - 1 \right) \times 100.$$

In other words, the value of the annual inflation rate, $\text{CPI-median}_t^{y/y}$, in a given month t is calculated as the cumulative monthly inflation rates based on the weighted median over the 12-month period ending in month t .

Measure of core inflation based on the common component (CPI-common)

CPI-common is a measure that tracks common price changes across the 55 components in the CPI basket.

As with CPI-trim and CPI-median, the input data for CPI-common are the CPI series for the 55 components adjusted to remove the effect of changes in indirect taxes. In addition, we use the historical

series of the All-items CPI adjusted to remove the effect of changes in indirect taxes to scale CPI-common to the inflation rate. Unlike CPI-trim and CPI-median, this measure is based on year-over-year percentage changes in price indexes. Therefore, the price index series are not seasonally adjusted when calculating CPI-common.

This measure is based on a factor model. Factor models are statistical methods that represent the variation in a set of variables as the sum of one or more factors representing co-movements across variables and an idiosyncratic term capturing the part unexplained by this (those) common factor(s). In the context of estimating core inflation, these models are used to separate the common source underlying the changes in CPI series from idiosyncratic elements that are related to sector-specific events (Khan, Morel and Sabourin (2013)).⁷ For each of the 55 components, $i = 1, 2, \dots, 55$, the model is written as follows (in the case of one common factor):

$$\pi_{i,t} = \Lambda_i F_t + \varepsilon_{i,t}; \quad i = 1, 2, \dots, 55; \quad t = 1, 2, \dots, T,$$

where T represents the total number of time periods available, $\pi_{i,t}$ represents the inflation rate of component i for the period t , which is related to the common factor F_t through factor loading Λ_i , and $\varepsilon_{i,t}$ is an idiosyncratic error term representing sector-specific disturbances that are uncorrelated with the common factor. In this model, the measure of core inflation is then defined as follows:

$$\tilde{\pi}_t = \Lambda F_t$$

where Λ is the matrix of factor loadings. For more information, see [Khan et al. \(2013\)](#).

In practice, CPI-common is calculated using the entire historical data of price index series and by following the steps below.

Step 1: We calculate annual inflation rates for the 55 components and for the All-items CPI excluding the effect of changes in indirect taxes. In a given month, the annual inflation rate for a given component is defined as the year-over-year percentage change in the price index for that month.

Step 2: The historical series of annual inflation rates for the 55 components are standardized. In other words, the historical series of annual inflation rates for each component is centred with respect to its average and then divided by its standard deviation.

Step 3: A factor model is estimated using data from the 55 historical series of annual standardized inflation rates. The principal components method is used for this purpose (Stock and Watson (2002a, 2002b)). This method involves creating 55 new variables, called principal components, each explaining a fraction of the variation found in all 55-historical series of annual inflation rates. The first principal component, which is associated with the highest eigenvalue, is the one that best explains the variation in the 55 historical series of annual inflation rates over the entire observation period. Only the first principal component is used in calculating CPI-common.⁸

Step 4: The final step is to scale the first principal component to the inflation rate. The measure of core inflation based on the common component, CPI-common, is defined and calculated as the series of predicted values from the simple linear regression of the annual inflation rates of the All-items CPI

excluding the effect of changes in indirect taxes (obtained in Step 1) on an intercept and on the first principal component calculated in Step 3.

Since CPI-common is based on a factor model, a standardization and a linear regression requiring all data available, the historical values for this measure are subject to revisions. An analysis of the magnitude of the revisions, reported in a Bank of Canada's Staff Working Paper (Khan et al. (2013)), suggests that revisions are relatively negligible.

Revisions and seasonal adjustment

These three measures of core inflation, CPI-trim, CPI-median and CPI-common, are subject to revision. For CPI-median and CPI-trim, this results from the fact that these measures are based on seasonally adjusted price index series. For CPI-common, revisions are due to the statistical technique used as the factor model is estimated over all available historical data.

When Statistics Canada introduces the CPI-trim and CPI-median measures in its November 2016 CPI release, 44 of the 55 historical series will be identified as seasonally adjusted, whereas others do not present any identifiable seasonal pattern. Since the technical parameters for seasonal adjustment are updated once a year, the number of series that are seasonally adjusted may change in the future depending on the historical series available that have (or do not have) an identifiable seasonal pattern. As with other CPI series, the approach used for seasonal adjustment involves each series to be seasonally adjusted separately. For more information, see the section "Revisions and seasonal adjustment" in the [CPI detailed information document](#).

The seasonally adjusted CPI series are subject to revision. Every month, the seasonally adjusted data for the previous seven years are revised.⁹ However, the models underlying the seasonal adjustment procedure are regularly revisited; as a result, they will be revised and updated when necessary.

Data accuracy

As with the CPI in general, statistical reliability is difficult to evaluate for the three preferred measures of core inflation. First, a statistical reliability indicator is not available for the price index series used as inputs to these measures. In addition, calculating these measures is complex, which makes it more difficult to evaluate their statistical reliability. For more information on the evaluation of the CPI data accuracy, see [this Statistics Canada publication](#). In practice, since the three measures are based on price index series calculated at the national level, their level of accuracy should be relatively comparable to that of All-items CPI.

References

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Appendix

Table A1: The 55 components used for the calculation of the Bank of Canada's preferred measures of core inflation

Category number	Category description
01	Meat
02	Fish, seafood and other marine products
03	Dairy products and eggs
04	Bakery and cereal products (excluding baby food)
05	Fruit, fruit preparations and nuts
06	Vegetables and vegetable preparations
07	Other food products and non-alcoholic beverages
08	Food purchased from restaurants
09	Rented accommodation
10	Mortgage interest cost
11	Homeowners' replacement cost
12	Property taxes and other special charges
13	Homeowners' home and mortgage insurance
14	Homeowners' maintenance and repairs
15	Other owned accommodation expenses*
16	Electricity
17	Water
18	Natural gas
19	Fuel oil and other fuels
20	Communications
21	Child care and housekeeping services
22	Household cleaning products
23	Paper, plastic and aluminum foil supplies
24	Other household goods and services
25	Furniture
26	Household textiles
27	Household equipment
28	Services related to household furnishings and equipment
29	Clothing
30	Footwear
31	Clothing accessories, watches and jewellery
32	Clothing material, notions and services
33	Purchase of passenger vehicles
34	Leasing of passenger vehicles*
35	Rental of passenger vehicles
36	Gasoline
37	Passenger vehicle parts, maintenance and repairs
38	Other passenger vehicle operating expenses
39	Local and commuter transportation

40	Inter-city transportation
41	Health care goods
42	Health care services
43	Personal care supplies and equipment
44	Personal care services
45	Recreational equipment and services (excluding recreational vehicles)
46	Purchase of recreational vehicles and outboard motors
47	Operation of recreational vehicles
48	Home entertainment equipment, parts and services
49	Travel services
50	Other cultural and recreational services
51	Education
52	Reading material (excluding textbooks)
53	Alcoholic beverages served in licensed establishments
54	Alcoholic beverages purchased from stores
55	Tobacco products and smokers' supplies

* This historical series is partly constructed by the Bank of Canada.

¹ This being said, monetary policy decisions should not be based on the mechanical use of these measures.

² The methodologies and data detailed in this document differ slightly from those used by the Bank to present the three measures in its document on the renewal of the inflation-control target in October 2016. The main changes are: (1) an increase in the number of price index components used (from 54 to 55); (2) a decrease in the number of seasonally adjusted price index series (from 54 to 44) due to the use of a new seasonal adjustment methodology; and (3) an update to the period used to estimate the CPI-common to reflect the most recent data.

³ January 1989 was chosen as the starting point to limit reclassification problems.

⁴ When the desired value of 20 per cent does not exactly correspond to a value in the discrete distribution of cumulative weights, an adjustment is made: the first component for which the cumulative weight is greater than 20 per cent is assigned the difference between its cumulative weight and 20 per cent.

⁵ This corresponds to a value of 80 per cent of cumulative weights. When this desired value of 80 per cent does not exactly correspond to a value in the discrete distribution of cumulative weights, an adjustment is made: the first component for which the cumulative weight is greater than 80 per cent is assigned the difference between 80 per cent and the value of the previous cumulative weight.

⁶ When the desired value of 50 per cent does not exactly correspond to a value in the discrete distribution of cumulative weights, the median value corresponds to the monthly inflation rate of the first component for which the cumulative weight is greater than 50 per cent.

⁷ The description of CPI-common presented in this document is largely based on Khan et al. (2013).

⁸ The choice of the number of common factors is based on a statistical selection criterion (Khan et al. (2013)). Moreover, we can intuitively assume that there is only one common source of changes in the different CPI components, and that this unique source would represent core inflation.

⁹ Revisions for CPI-trim and CPI-median that result from seasonal adjustment proved negligible after seven years.