OECD calculation of contributions to overall annual inflation

INTRODUCTION

Since 2015, <u>national</u> Consumer Price Index (CPI) series broken down into COICOP components[1], as well as the associated expenditure weights, are available on OECD.Stat[2]. This national CPI data collection at a detailed level is jointly coordinated by the OECD and the IMF.

The OECD would like to release contributions to annual inflation for its member countries from 2010 onwards, based on <u>national</u> CPIs[3]. Eurostat is also about to disseminate on its website contributions to inflation based on <u>Harmonised</u> Indices of Consumer Prices (HICP). Both initiatives aim at providing additional information to users for the analysis of changes in annual inflation rates.

After a short review of country practices, this note presents the underlying methodology to calculate contributions to annual inflation, which depends on whether countries use fixed weights or annually updated weights.

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[1] March 2022 update: the original note (published in May 2018) refers to the COICOP 1999 classification and its 12 COICOP divisions. The new version of the COICOP classification, namely COICOP 2018 classification, refers to 13 divisions. Some countries such as Chile and Japan are already publishing their CPIs in reference to this new version of COICOP classification. The methodology used to calculate the contributions to annual inflation remains the same regardless of the 12 or 13 COICOP divisions reference.

[2] http://stats.oecd.org/Index.aspx?DataSetCode=PRICES_COICOP

[3] For an overview of the HICP, please consult Eurostat's HICP Methodological Manual at: HICP Methodological Manual (europa.eu)

1. Overview of country practices

The number of countries currently calculating and publishing contributions to annual inflation for the COICOP components available on OECD.Stat is relatively small. So far, contributions to inflation are only published by Greece[4], Ireland[5], Iceland[6], Israel[7], the Netherlands[8] and the United-Kingdom[9]. Except Israel, all of these countries publish chain-linked indices with annually updated weights.

The overall price index (CPI All items) is constructed as a weighted average of sub-indices. For the aggregation of sub-indices, a Laspeyres-type formula[10] is used in all OECD countries except Sweden (see Annex Table 1)[11].

Different NSOs update CPI weights at different frequencies, between every year and every ten years. CPI weight updates reflect the fact that consumers adjust the composition of their expenditure when relative prices change. Therefore, weight updates aim at limiting the substitution bias in the CPI. Each time weights are updated, price indices need to be chain-linked to construct longer time series.

The contribution of COICOP component j to overall annual inflation depends on its weight in the consumption basket and its own inflation rate. Contribution formulas are different when one or two sets of expenditure weights enter into the computation of annual inflation. Section 2 covers the case when only one set of weights is needed, which is possible when weights are kept fixed for more than a year. Section 3 deals with the case when expenditure weights are annually updated, in December, which is a very usual case in practice. Even though these two sections are applicable to many situations, please note that they do not cover all specific cases. For example, expenditure weights may be annually updated in another month than December (*e.g.* Norway updates CPI weights in January). Moreover, even when expenditure weights are kept fixed for more than a year, they need to be changed at some point, in which case two sets of weights enter into the computation of annual inflation. In these cases, the contribution formulas need to be adjusted, but they rest on the same general principles described in Sections 2 and 3.

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[4] See "Effect" in Table *2* of the monthly CPI press release PDF file, available at:
 http://www.statistics.gr/en/statistics/-/publication/DKT87/2017-M10

[5] See "Contributions to changes in the Consumer Price Index by Month, COICOP Group and Statistics" in Table *CPM11* available at: http://www.cso.ie/px/pxeirestat/Statire/SelectVarVal/Define.asp?maintable=CPM11&PLanguage=0

[6] See "Effect on the CPI" in the Table *Consumer price index by expenditure groups and monthly changes from 2002* at:
 https://px.hagstofa.is/pxen/pxweb/en/Efnahagur/Efnahagur__visitolur__1_vnv__2_undirvisitolur/VIS01301.px

[7] See https://www.cbs.gov.il/en/subjects/Pages/Consumer-Price-Index.aspx

[8] See "Contribution and impact" available in the Table *Consumer prices; contribution and impact, CPI 2015=100* at: https://opendata.cbs.nl/statline/#/CBS/en/dataset/83132ENG/table?ts=1511778716115

[9] See "CPI: Contribution to monthly change in all items index" and "CPI: Contribution to all items annual rate" available in *Consumer Price Inflation time series dataset* at:
 https://www.ons.gov.uk/economy/inflationandpriceindices/datasets/consumerpriceindices

[10] We use the "Laspeyres-type" wording to describe all price indices whose expenditure weights are constructed using past information only. They measure changes in the total cost of an annual basket of goods and services that may date back several years before the price reference period. Statistical offices may also adjust old expenditure shares in order to reflect relative price movements between the date when expenditure shares were collected and the price reference period, but this requires assumptions to be made on how expenditure shares are related to relative price movements. True Laspeyres indices would require the basket to be exactly the one consumed in the price reference month (see 2004 CPI Manual, §9.89).

[11] The appropriate method to compute contributions to inflation still needs to be discussed with Sweden.

2. Contributions to overall annual inflation when expenditure weights are kept fixed for more than a year

When expenditure weights are kept fixed for more than a year, a single set of weights may be enough to compute annual inflation[12]. In this case, the overall annual rate of inflation $\pi_{TOT}^{y,m}$ can be decomposed as follows:

$$\pi_{TOT}^{y,m} \equiv \frac{P_{TOT}^{y,m}}{P_{TOT}^{y-1,m}} - 1 = \frac{\sum_j W_j^{y_0,m_0} P_j^{y,m}}{\sum_j W_j^{y_0,m_0} P_j^{y-1,m}} - 1$$

$$= \sum_j \left[\frac{W_j^{y_0,m_0} P_j^{y-1,m}}{\sum_j \left(W_j^{y_0,m_0} P_j^{y-1,m} \right)} \cdot \frac{P_j^{y,m}}{P_j^{y-1,m}} \right] - 1 = \sum_j \underbrace{\frac{W_j^{y_0,m_0} P_j^{y-1,m}}{\sum_j \left(W_j^{y_0,m_0} P_j^{y-1,m} \right)}}_{= \frac{P_j^{y-1,m}}{P_{TOT}^{y-1,m}} \cdot W_j^{y_0,m_0}} \cdot \underbrace{\left(\frac{P_j^{y,m}}{P_j^{y-1,m}} - 1 \right)}_{\equiv \pi_j^{y,m}}$$

Notations:

$W_j^{y_0,m_0}$ is the expenditure weight of COICOP component j in month m_0 of year y_0 (base period);

$P_{TOT}^{y,m}$ is the overall price index in month m of year y $\left(P_{TOT}^{y_0,m_0} = 100 \right)$;

$P_j^{y,m}$ is the price index of COICOP component j in month m of year y $\left(P_j^{y_0,m_0} = 100 \right)$;

$\pi_{TOT}^{y,m}$ is the overall annual inflation rate in month m of year y;[13]

$\pi_j^{y,m}$ is the annual inflation rate of COICOP component j in month m of year y;

The previous expression shows the weights that need to be applied to $\pi_j^{y,m}$ in order to compute the overall annual inflation rate. Note that the expenditure weights $W_j^{y_0,m_0}$ are rescaled to $\frac{P_j^{y-1,m}}{P_{TOT}^{y-1,m}} \cdot W_j^{y_0,m_0}$. This rescaling is a way to price-update expenditure weights to month m of year $(y\text{-}1)$.

The contribution of COICOP component j to the overall annual rate of inflation in month m of year y can be written as follows[14]:

$$Contrib_j^{y,m} = \left(\frac{P_j^{y-1,m}}{P_{TOT}^{y-1,m}} \cdot W_j^{y_0,m_0} \right) * \pi_j^{y,m} = \underbrace{W_j^{y_0,m_0}}_{(1)} * \underbrace{\frac{P_j^{y,m} - P_j^{y-1,m}}{P_{TOT}^{y-1,m}}}_{(2)}$$

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[12] Keeping expenditure weights fixed for more than a year does not mean using them forever. In practice, expenditure weights in OECD countries are updated every 10 years at most (see Annex Table 2). When weights are updated, overall annual inflation depends on two different sets of weights. In this case, the calculation of contributions to overall annual inflation is similar to what is described in Section 3.

[13] Australia and New Zealand calculate quarterly consumer price index only. All formulas that refer to monthly CPI data apply also in the case of quarterly data and should refer to quarterly Q instead of month m.

[14] The terms (1) and (2) correspond to two different Excel sheets in the accompanying Excel files. Note that (1) corresponds to the original (*i.e.* not price-updated) weights $W_j^{y_0,m_0}$. Therefore, (2) does not correspond to $\pi_j^{y,m}$, the inflation rate of COICOP component j, but to $\frac{P_j^{y-1,m}}{P_{TOT}^{y-1,m}} \cdot \pi_j^{y,m}$.

3. Contribution to overall annual inflation when expenditure weights are annually updated

When expenditure weights are annually updated, price indices spanning more than a year are chain-linked and the formula to compute contributions to inflation between month m of year $(y-1)$ and month m of year y needs to be modified.[15] Using similar notations as in the previous section, the exposition below closely follows Walschots (2016)[16]. Annual inflation $\pi_{TOT}^{y,m}$ can thus be decomposed as follows[17]:

$$\pi_{TOT}^{y,m} \equiv \frac{P_{TOT}^{y,m} - P_{TOT}^{y-1,m}}{P_{TOT}^{y-1,m}}$$

$$= \frac{P_{TOT}^{y-1,12}}{P_{TOT}^{y-1,m}} \sum_j \left[W_j^{y-1,12} \frac{P_j^{y,m}}{P_j^{y-1,12}} \right] - \frac{P_{TOT}^{y-2,12}}{P_{TOT}^{y-1,m}} \sum_j \left[W_j^{y-2,12} \frac{P_j^{y-1,m}}{P_j^{y-2,12}} \right]$$

$$= \frac{P_{TOT}^{y-1,12}}{P_{TOT}^{y-1,m}} \sum_j \left[W_j^{y-1,12} \left(\frac{P_j^{y,m}}{P_j^{y-1,12}} - 1 \right) \right] + \underbrace{\frac{P_{TOT}^{y-1,12}}{P_{TOT}^{y-1,m}}}_{= \frac{P_{TOT}^{y-2,12}}{P_{TOT}^{y-1,m}} \Sigma_j \left[W_j^{y-2,12} \frac{P_j^{y-1,12}}{P_j^{y-2,12}} \right]} - \frac{P_{TOT}^{y-2,12}}{P_{TOT}^{y-1,m}} \sum_j \left[W_j^{y-2,12} \frac{P_j^{y-1,m}}{P_j^{y-2,12}} \right]$$

$$= \frac{P_{TOT}^{y-1,12}}{P_{TOT}^{y-1,m}} \sum_j \left[W_j^{y-1,12} \left(\frac{P_j^{y,m} - P_j^{y-1,12}}{P_j^{y-1,12}} \right) \right] + \frac{P_{TOT}^{y-2,12}}{P_{TOT}^{y-1,m}} \sum_j \left[W_j^{y-2,12} \left(\frac{P_j^{y-1,12} - P_j^{y-1,m}}{P_j^{y-2,12}} \right) \right]$$

The contribution of COICOP component j to the overall annual rate of inflation in month m of year y can be written as follows[18]. By construction, these contributions sum to overall inflation.

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[15] Australia and New Zealand calculate quarterly consumer price indices only. All formulas that refer to monthly CPI data apply also in the case of quarterly data and should refer to quarterly Q instead of month m, and fourth quarter (4) instead of December (12).

[16] Walschots (2016) also discusses Eurostat's method to calculate "impacts" on inflation. This approach has been discontinued since January 2018 in favour of the same contributions described here.

[17] The resulting contribution formula is called a "Ribe" contribution formula by Balk and Mehrhoff (2018) who present it on the basis of unchained indices, whereas we present it here on the basis of chain-linked indices. Contrary to the "Kirchner" contributions proposed by the Deutsche Bundesbank to compute contributions to GDP growth, and adapted to CPI inflation by Balk and Mehrhoff (2018), "Ribe" contributions are additive by construction, up to rounding errors, which is their main advantage. In practice, except for countries or periods with a 2-digit inflation, "Ribe" and "Kirchner" contributions are very close to each other. Finally, please note that contributions to HICP inflation that Eurostat is about to release on its website are also "Ribe" contributions.

[18] The six terms of this formula correspond to six different Excel sheets in the accompanying Excel files.

$$Contrib_j^{y,m} = \left[\left(\underbrace{\frac{P_{ToT}^{y-1,12}}{P_{ToT}^{y-1,m}}}_{(1)} * \underbrace{W_j^{y-1,12}}_{(2)} \right) * \left(\underbrace{\frac{P_j^{y,m} - P_j^{y-1,12}}{P_j^{y-1,12}}}_{(3)} \right) \right]$$

$$+ \left[\left(\underbrace{\frac{P_{ToT}^{y-2,12}}{P_{ToT}^{y-1,m}}}_{(4)} * \underbrace{W_j^{y-2,12}}_{(5)} \right) * \left(\underbrace{\frac{P_j^{y-1,12} - P_j^{y-1,m}}{P_j^{y-2,12}}}_{(6)} \right) \right]$$

Notations:

$W_j^{y-1,12}$ is the expenditure weight corresponding to COICOP component j in December of year $(y\text{-}1)$ and used for the link from December of year $(y\text{-}1)$ until December of year y;

$P_{TOT}^{y,m}$ is the overall price index in month m of year y;

$P_j^{y,m}$ is the price index of COICOP component j in month m of year y;

The first part of the above formula (terms 1 to 3) takes into account price developments that occurred between December of year $(y\text{-}1)$ and month m of year y, whereas its second part (terms 4 to 6) takes into account price developments that occurred between month m of year $(y\text{-}1)$ and December of year $(y\text{-}1)$. This cut in December of year $(y\text{-}1)$ is introduced due to the change in expenditure weights that is introduced after this month.

Note that when m = 12 (December), the second part of the formula is equal to zero and the first part simplifies as follows, which leads to the same contribution formula as in the fixed basket case when $y_0 = y - 1$ and $m_0 = 12$:

$$Contrib_j^{y,12} = \underbrace{W_j^{y-1,12}}_{(2)} * \underbrace{\frac{P_j^{y,12} - P_j^{y-1,12}}{P_j^{y-1,12}}}_{\equiv \pi_j^{y,12}:\ (3)}$$

4. Calculation of contributions to overall annual inflation: different cases to consider in practice

In practice, there are three possible cases for calculating contributions to annual inflation, depending on the frequency of weight updates:

1. Countries using weights that are kept fixed for more than a year, over the entire period (from January 2010 onwards)
2. Countries using annually updated weights over the entire period (from January 2010 onwards)
3. Countries using fixed weights in the first part of the sample, and switching to annually updated weights at some point

Countries using weights that are kept fixed for more than a year, over the entire period (from January 2010 onwards)

Canada, Chile, the Czech Republic, Germany, Israel, Japan, Korea, Mexico and New Zealand use fixed weights which are updated every 2 to 10 years depending on countries.

Countries using annually updated weights over the entire period (from January 2010 onwards)

22 OECD countries use annually updated weights over the entire period. In this case, the computation of contributions to annual inflation from January 2010 onwards necessitates price indices for each COICOP component and expenditure weights starting in 2008.

Countries using fixed weights in the first part of the sample, and switching to annually updated weights at some point

Some countries have introduced annual weight updates later than January 2010. This is the case of Belgium, Finland, Greece and Ireland, which have introduced annual weight updates in January 2014, January

2013, January 2014 and January 2012, respectively. Before that, they relied on fixed weight indices. For these four countries, the method to compute contributions needs to be changed at some point.

Annex Table 2 gives further information on the frequency of weight updates in OECD countries.

References

- Balk B.M., Mehrhoff J. (2018): Index Calculation. *Chapter 8 in HICP Methodological Manual. Eurostat.* Forthcoming
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- ILO et al. (2020): Consumer Price Index Manual – Theory and Practice.
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- Walschots J. (2016): Contributions to and Impacts on Inflation. *Statistics Netherlands*.
Contribution to and impact on inflation (cbs.nl)

Annex tables

Annex Table 1 - CPI calculation methods in OECD countries

Country	Method(s) to compile elementary indices*	Aggregation formula	Source(s) for expenditure weights
Australia	Predominantly geometric mean of price relatives (Jevons Index) and exceptionally (e.g. for education), ratio of the arithmetic mean of prices (Dutot index)	Laspeyres-type formula	Household expenditure survey
Austria	Geometric mean of price relatives (Jevons Index)	Laspeyres-type formula	Household budget survey
Belgium	Geometric mean of price relatives (Jevons Index)	Laspeyres-type formula	Household budget survey
Canada	Predominantly geometric mean of price relatives (Jevons Index) and, in a few cases, unit value index.	Laspeyres-type formula	Survey of household spending
Chile	Geometric mean of price relatives (Jevons Index)	Laspeyres-type formula	Household budget survey
Czech Republic	Ratio of the arithmetic mean of prices (Dutot index).	Laspeyres-type formula	Household budget survey and national accounts
Denmark	Geometric mean of price relatives (Jevons Index)	Laspeyres-type formula	Household budget survey and national accounts
Estonia	Ratio of the arithmetic mean of prices (Dutot index).	Laspeyres-type formula	National accounts
Finland	Geometric mean of price relatives (Jevons Index)	Laspeyres-type formula	National accounts
France	Geometric mean of price relatives (Jevons Index) for heterogeneous elementary aggregates, and ratio of the arithmetic mean of prices (Dutot index) for homogeneous elementary aggregates.	Laspeyres-type formula	National accounts
Germany	Ratio of the arithmetic mean of prices (Dutot index)	Laspeyres-type formula	Household budget survey, national accounts and tax statistics
Greece	..	Laspeyres-type formula	Household budget survey
Hungary	Ratio of the arithmetic mean of prices (Dutot index)	Laspeyres-type formula	National accounts, Household Budget and Living Conditions Survey (HBLS), retail trade data
Iceland	Geometric mean of price relatives (Jevons Index)	Laspeyres-type formula	National accounts and household budget survey
Ireland	Geometric mean of price relatives (Jevons Index)	Laspeyres-type formula	Household budget survey
Israel	Ratio of the arithmetic mean of prices (Dutot index)	Laspeyres-type formula	Household budget survey

* At this level, expenditure shares are typically unavailable and elementary indices are based on unweighted means of price observations.

Annex Table 1 - CPI calculation methods in OECD countries (Continued)

Country	Method(s) to compile elementary indices*	Aggregation formula	Source(s) for expenditure weights
Italy	Geometric mean of price relatives (Jevons Index)	Laspeyres-type formula	National accounts
Japan	Ratio of the arithmetic mean of prices (Dutot index)	Laspeyres type formula	Survey information (average of household living expenditure by municipality)
Korea	Geometric mean of price relatives (Jevons Index) or ratio of the arithmetic mean of prices (Dutot index).	Laspeyres type formula	Household Income and Expenditure Survey (HIES)
Latvia	Ratio of the arithmetic mean of prices (Dutot index)	Laspeyres-type formula	Household budget survey and national accounts
Luxembourg	Geometric mean of price relatives (Jevons Index)	Laspeyres-type formula	Household budget survey and national accounts
Mexico	Geometric mean of price relatives (Jevons Index).	Laspeyres-type formula	National Survey of Household Income and Expenditure (ENIGH)
Netherlands	Ratio of arithmetic mean of prices (Dutot index)	Laspeyres-type formula	..
New Zealand	..	Laspeyres-type formula	Household expenditure survey
Norway	Geometric mean of price relatives (Jevons Index)	Laspeyres-type formula	Household budget survey and national accounts Scanner data
Poland*	Ratio of the arithmetic mean of prices (Dutot index)	Laspeyres-type formula	Household budget survey
Portugal	Geometric mean of price relatives (Jevons Index)	Laspeyres-type formula	Household budget survey
Slovak Republic	Ratio of the arithmetic mean of prices (Dutot index)	Laspeyres-type formula	Household budget survey and national accounts
Slovenia	Ratio of the arithmetic mean of prices (Dutot index)	Laspeyres-type formula	National accounts
Spain	Geometric mean of price relatives (Jevons Index)	Laspeyres-type formula	Household budget survey
Sweden	Geometric mean of price relatives (Jevons Index)	Superlative index formula (Walsh)	Household budget survey and national accounts
Switzerland	Geometric mean of price relatives (Jevons Index)	Laspeyres-type formula	Household budget survey
Turkey	Geometric mean of price relatives (Jevons Index).	Laspeyres-type formula	Household budget survey
United Kingdom	Geometric mean of price relatives (Jevons Index)	Laspeyres-type formula	National accounts and household budget survey
United States	Geometric mean of price relatives (Jevons Index) and, in a few cases, arithmetic mean of price relatives (Carli index). Both benefit from weighting using the sampling frame of the strata and are respectively estimators of weighted geometric and Laspeyres indexes.	Laspeyres-type formula	Telephone Point of Purchase Survey (TPOPS), Consumer expenditure survey

Annex Table 2 – CPI weights updates in OECD countries

Country	Annually updated weights	Fixed weights for more than a year	
	Period	Period	Weight base year (as published by country)
Australia	January 2010-current month	..	
Austria	January 2010-current month	..	
Belgium	January 2014-current month	January 2010-December 2013	2005
Canada	..	January 2010-December 2011	2009
		January 2012-December 2013	2011
		January 2014-December 2015	2013
		January 2016-December 2017	2015
		January 2018-December 2019	2017
		January 2020-December 2021	2019
		January 2022-December 2017	2021
Chile	..	January 2010-December 2013	2009
		January 2014-December 2018	2013
		January 2019 – Current month	2018
Czech Republic	..	January 2010-December 2011	2009
		January 2012-December 2013	2011
		January 2014-December 2015	2013
		January 2016-December 2017	2015
		January 2017-December 2018	2017
		January 2019-December 2020	2019
		January 2021 – Current month	2021
Denmark	January 2010-current month	..	
Estonia	January 2010-current month	..	
Finland	January 2013-Current month	January 2010-December 2010 (data non available)	2006
		January 2011-December 2012	2011
France	January 2010-current month	..	
Germany	..	January 2010-December 2010	2005
		January 2011- December 2015	2010
		January 2016-Current month	2015
Greece	January 2014-Current month	January 2010-Avril 2011	2005
		May 2011-December 2013	2011
Hungary	January 2010-current month	..	
Iceland	January 2010-current month	..	
Ireland	January 2012 –Current month	January 2010-December 2011	2006

Country	Annually updated weights	Fixed weights for more than a year	
	Period	Period	Weight base year (as published by country)
Israel	..	January 2010-December 2010	2009
		January 2011-December 2012	2011
		January 2013-December 2014	2013
		January 2015-December 2016	2015
		January 2017-December 2018	2017
		January 2019-December 2020	2019
		January 2021-Current month	2021
Italy	January 2010-current month	..	
Japan	..	January 2010-December 2010	2005
		January 2011-December 2016	2010
		January 2017- December 2019	2015
		January 2020 – Current month	2020
Korea	..	January 2010-December 2011	2010
		January 2012-December 2014	2012
		January 2015- December 2019	2015
		January 2015-Current month	2020
Latvia	January 2010-current month	..	
Luxembourg	January 2010-current month	..	
Mexico	..	January 2010-December 2010	2001
		January 2011-March 2013	2010
		April 2013-July 2018	2012
		August 2018-Current month	2018
Netherlands	January 2010-current month	..	
New Zealand	..	January 2010-December 2011	2008
		January 2012-December 2014	2011
		January 2015-Current month	2014
Norway	January 2010-current month	..	
Poland	January 2010-current month	..	
Portugal	January 2010-current month	..	
Slovakia	January 2010-current month	..	
Slovenia	January 2010-current month	..	
Spain	January 2010-current month		
Sweden	January 2010-current month	..	

Annex Table 2 – CPI weights updating in OECD countries (Continued)

Country	Annually updated weights	Fixed weights for more than a year	
	Period	**Period**	**Weight base year (as published by country)**
Switzerland	January 2010-current month	..	
Turkey	January 2010-current month	..	
United Kingdom	January 2010-current month	..	
United States	January 2010-current month	..	