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Chain linking over December and methodological changes in the HICP: view from a central bank perspective

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Contents

Abstract

Consumer price inflation, as measured by the year-on-year increase in the Harmonised Index of Consumer Prices (HICP), is used by the European Central Bank (ECB) for assessing its monetary policy. The European Statistical System regularly introduces methodological improvements into this chain-linked price index in the linking month (December). If the outcome of such changes is a new series with a very different profile in December – either due to changed seasonality or one-off (sampling) effects – significant statistical distortions may arise when the new index series is chain-linked to the existing series. This paper explains the mechanism behind statistical distortions due to chain linking and provides some recent examples from European price statistics. Several alternative chain-linking practices, as well as recommendations for data users on how to deal with such statistical breaks in the HICP, are presented.

Keywords: Consumer prices, chain linking, index aggregation methods, seasonality, central bank communication.

JEL Classification: C43, E31.

Non-technical summary

Consumer price inflation, as measured by the year-on-year increase in the Harmonised Index of Consumer Prices (HICP), is the basis for the ECB Governing Council 's definition of price stability and its related communication. The HICP is a chain-linked price index, with expenditure weights updated every December. Moreover, major methodological improvements by national statistical institutes (NSIs), such as new data sources or changes in the index compilation, may also be incorporated when the HICP weights are updated. If the outcome of such major changes is a new series with a very different profile in the linking month of December – either due to changed seasonality or one-off (sampling) effects – significant statistical distortions, in the form of a level shift, may arise when the new index series is chain linked to the old series.

This paper explains the technical mechanism behind statistical distortions due to chain linking. Notably, the year-on-year rates from January to November, as well as the annual average rate, in the first year following the introduction of a methodological change are biased, with the sign of the bias depending on the ratio between the old and new December index value. Several recent examples in European price statistics are presented below, in which the chain-linking practice over December exacerbated the statistical break in the index series. With regard to the HICP "package holidays" and "accommodation services" components, evidence of such statistical biases is to be found for Germany, Denmark and Sweden.

The paper presents three alternative ways to correct for the level shift in the HICP series due to chain linking: a level correction through an overlapping annual average, which requires backdata for at least one year; a level correction based on the previous year's average (in the absence of any backdata); and a "de-quirking" method, where the old index series is corrected for differences in the seasonal pattern applying the new methodology. To preserve the annual average rate of inflation, it is recommended that a level correction through an overlapping annual average be used. As regards statistical biases, the "de-quirking" method would perform best; however, owing to the implied revisions of the entire HICP series, it is not well suited to regular statistical production.

All in all, individual linking practices that may be applied by data users on a case-by-case basis may make it possible to treat a statistical distortion in a way that best fits the user's purpose. Nevertheless, the paper stresses the need for a more flexible application of chain linking to the HICP in the European Statistical System's guidelines to avoid such statistical biases. In the light of this statistical distortions arising from the current HICP chain-linking technique might be exacerbated by the introduction of new digital data sources, such as web scraping and scanner data.

1 Introduction

Consumer price inflation, as measured by the year-on-year increase in HICP, is the European Central Bank's official reference for assessing price stability, the aim being that inflation rates should be "below, but close to, 2% over the medium term". Hence, the annual growth rates of the HICP play a crucial role in the monetary policy deliberations of the ECB Governing Council and related communication. Consequently, the HICP is both in the public eye and subject to much analysis by economists. While year-on-year growth rates are primarily used in monitoring and assessment, Eurosystem/ECB macroeconomic forecasting, modelling and analyses also use the (seasonally adjusted) month-on-month growth rates of the HICP series. Moreover, annual average rates may be used for long-term policy evaluations.

The HICP is a chain-linked price index based on a Laspeyres-type formula, with expenditure weights updated every December.[1] This makes it possible to reflect market changes and consumers' substitution behaviour more effectively as compared with a fixed-base approach. In addition, major methodological improvements by NSIs such as new data sources or changes in the index compilation, may also be incorporated when HICP weights are updated. Generally, these amendments aim to enhance the quality of the price index and the impact of such changes on the dynamics of the index series is often not particularly large. However, if the outcome of such major changes is a new series with a very different (seasonal) profile in the linking month of December, statistical distortions of a marked magnitude may arise when chain linking the new index series to the old series.

The aim of this paper is to point to the impact that current chain-linking practices by NSIs might have on the HICP, especially on annual inflation rates feeding central bank analyses and communication. In this regard, the paper makes a case for providing statistical compilers with potential options for compiling chain-linked indices, given that the seasonal pattern of price series might abruptly change, or simply that one-off effects from sampling might occur, e.g. when new digital data sources are added.

The structure of this paper is as follows. First, it provides an overview of the current HICP practice of chain linking over December (Section 2). Next, it explains the mechanisms behind statistical distortions arising from chain linking two series with a different (seasonal) profile; this is followed by some recent examples from European price statistics (Section 3). Several alternative chain-linking practices, as well as recommendations for data users on how to deal with such statistical breaks in the HICP, are then discussed (Section 4). Finally, conclusions are drawn (Section 5).

[1] The HICP measures the change over time in the prices of goods and service for euro area households. See Eurostat (2018) for a detailed description of the recommendations for euro area NSIs on price collection and the derivation of annual expenditure weights in order to provide a harmonised framework.

2 The HICP chain-linking technique and its properties

In a broad sense, chain linking involves constructing a long-term time series by multiplying short-term price indices; by doing so, it is possible to update the weights and sample of prices covered by each short-term index.[2] The HICP approach to chain linking applied by European NSIs, i.e. to chain link the index series over December, is set out in Article 2(16) of the HICP Framework Regulation[3], which specifies that the *price reference period*, i.e. the period to which a price in a given month is compared, is December of the previous year. On this basis, the HICP is calculated as a series of 13-month aggregate index numbers from December of year $t-1$ (denoted by $0t$) to December of year t (denoted by $12t$). These index numbers are chain linked by multiplying the chain-linked index for December of the previous year series by the index number for every month of the short-term series (divided by 100), using December as the *overlap* or *linking month*. Therefore, the chain-linked price index CP for month m of year t, with b being the *index reference period*, is calculated as follows:

$$CP^{b,mt} = CP^{b,12(t-1)} \cdot P^{0t,mt}, \tag{1}$$

where $P^{0t,mt}$ is the Laspeyres-type price index of year t, with $0t$ as the price reference month (i.e. December of the previous year) and mt as the reporting month.

Generally, three techniques for chain linking monthly indices which use annual weights are considered in practice: the *one-month overlap technique* (e.g. December overlaps), which is applied for the HICP, the *annual overlap technique* (overlap with the annual average of the previous year), and the *over-the-year technique* (overlap with same month of the previous year).[4] Table 1 shows how these techniques perform in terms of the properties of key measures derived, i.e. monthly and annual year-on-year rates of change, which are intensively used in monetary policy discussions, and annual averages. In the case of price indices, the term "bias" means that the chain-linked price index not only reflects changes in prices, but may also be affected by annually updated quantities related to the incorporation of new information into the HICP weights (e.g. from national accounts).[5] Test calculations have indicated that these biases are not very large if structural changes in weights over time are moderate.[6]

2 See Eurostat (2018), Chapter 8 "Index calculation".

3 See Regulation (EU) 2016/792 of the European Parliament and of the Council of 11 May 2016 on harmonised indices of consumer prices and the house price index, and repealing Council Regulation (EC) No 2494/95.

4 See IMF (2018), Chapter 8 "Price and Volume Measures", for details of these chain-linking techniques for quarterly time series.

5 See Eurostat (2018), Chapter 8 "Index calculation", footnote 83.

6 See Eurostat and ECB (2008), p. 24.

Table 1

Properties of chain-linking techniques

Key measure/ technique	Year-on-year rates of change	Month-on-month rates of change	Annual average rates
One-month overlap technique	December unbiased, otherwise biased	**Unbiased**	Biased
Annual overlap technique	Biased	January biased, otherwise unbiased	**Unbiased**
Over-the-year technique	**Unbiased**	**Not meaningful**	Approximately unbiased

Note: See Mehrhoff (2017).

As regards the three methods of chain linking, the *over-the-year technique* keeps year-on-year rates of change undistorted. This suggests that this linking technique might be preferable for measures such as the HICP for which annual rates of change are of primary interest. However, it can be shown that chain-linked series compiled using the *over-the-year technique* may exhibit an artificial seasonal pattern which tends to become more pronounced over time, even if the underlying component series do not show any seasonality.[7] For this reason, the *over-the-year technique* cannot be recommended for compiling chain-linked index series.[8]

In the course of establishing the HICP legal framework in the mid-1990s, price statisticians began to view chain linking as a superior alternative for compiling official price statistics as compared with the then established fixed-base approach. The *one-month overlap* (December-overlap) *technique* was preferred over the *annual overlap technique* for the compilation of chain-linked time series for price indices, since the former requires the parallel calculation of indices – based on the old and the new basket, sampling, weighting scheme and methodological treatments – but for December only rather than for the entire previous year. However, one drawback comes from using just one overlap month. Generally, the value in a linking period – month or year – affects a chain-linked time series from the point in time at which the recent index is linked to that value. Chain-linked index series are "path dependent", i.e. affected by the values of each linking period, which have a permanent impact on the time series.[9] Values in linking periods which deviate significantly from the trend of a time series tend to appear more often and to be more pronounced in monthly data, while the impact of such phenomena tends to be less pronounced when annual figures are considered.

Seasonality is a typical case in which monthly figures exhibit high or low values while the annual average is not affected, by definition. Hence, chain-linked time series compiled by means of the *one-month overlap technique* tend to show more pronounced shifts caused by unusual values, seasonal peaks or troughs in the linking month than series obtained using the *annual overlap technique*.[10]

7 See IMF (2018), paragraph 8.70, as well as Eiglsperger (2008).

8 See Eurostat (2013).

9 See Mehrhoff (2017).

10 In contrast, the *annual overlap technique* is applied by most EU Member States for compiling volume measures in national accounts.

In the run-up to the introduction of the HICP framework, price indices showed hardly any significant seasonal patterns caused by price fluctuations within a calendar year.[11] Hence, situations in which the December values of a price index were systematically higher or lower compared with the index trend movement did not figure significantly in discussions of the chain-linking techniques appropriate for price indices. For the HICP, however, seasonal patterns have become pronounced in several areas since then. For instance, the requirement to incorporate prices for services at the time they are normally consumed and the harmonised treatment of seasonal items incorporated into the HICP from 2011 resulted in considerable seasonal profiles, including, in several cases, in the linking month December, e.g. due to peak prices for flights and package holidays over Christmas.[12]

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11 Price index theory places seasonal patterns in price indices under “weak seasonality”, i.e. those movements which recur with similar intensity in the same season each year, while seasonal unavailability of prices is called “strong seasonality”.

12 See Commission Regulation (EC) No 330/2009 of 22 April 2009 laying down detailed rules for the implementation of Council Regulation (EC) No 2494/95 as regards minimum standards for the treatment of seasonal products in the Harmonised Indices of Consumer Prices (HICP). Likewise, the introduction of including price reductions led to a change in seasonal patterns, see Commission Regulation (EC) No 2602/2000 of 17 November 2000 laying down detailed rules for the implementation of Council Regulation (EC) No 2494/95 as regards minimum standards for the treatment of price reductions in the Harmonised Index of Consumer Prices.

3 Statistical distortions due to chain linking over December

In the following section, the theoretical mechanism underlying the statistical distortions due to chain linking are explained (Section 3.1). In a next step, the most recent EU country examples are given in which the current HICP chain-linking practice exacerbated a statistical break in the respective index series (Section 3.2).

3.1 Theoretical underpinning

To provide a more thorough understanding of statistical distortions due to the chain linking of two series with a different seasonal pattern, a theoretical example is given which closely follows the presentation given in Mehrhoff (2014).[13] For this purpose, it is assumed that the price of a single good can be decomposed into a non-seasonal component π and seasonal component σ.[14] The (multiplicative) decomposition for price p of item i in month m of year t is then given by[15]

$$p_i^{mt} = \pi_i^{mt} \cdot \sigma_i^{mt}. \tag{2}$$

Without loss of generality, it is assumed that the HICP subindices consist of a single good only – but are still chain linked to December of the previous year, as described above. The calculation of a chain-linked price index for month m in the year 2015 with period “0” equal to December 2013 then yields:

$$\begin{aligned}\tilde{p}_i^{m,2015} &= p_i^{12,2013} \cdot \frac{p_i^{12,2014}}{p_i^{12,2013}} \cdot \frac{{p'}_i^{m,2015}}{{p'}_i^{12,2014}} \\ &= \pi_i^{12,2013} \cdot \sigma_i^{12,2013} \cdot \frac{\pi_i^{12,2014} \cdot \sigma_i^{12,2014}}{\pi_i^{12,2013} \cdot \sigma_i^{12,2013}} \cdot \frac{\pi_i^{m,2015} \cdot {\sigma'}_i^{m,2015}}{\pi_i^{12,2014} \cdot {\sigma'}_i^{12,2014}} \\ &= \pi_i^{m,2015} \cdot {\sigma'}_i^{m,2015} \cdot \frac{\sigma_i^{12,2014}}{{\sigma'}_i^{12,2014}} = {p'}_i^{m,2015} \cdot \frac{\sigma_i^{12,2014}}{{\sigma'}_i^{12,2014}} \neq {p'}_i^{m,2015},\end{aligned} \tag{3}$$

where p' is the monthly price according to the new seasonal profile σ'. Noticeably, the change in the seasonal pattern for December leads to a level shift for the chain-linked index in January of the first year, applying the new methodology. The shift equals the

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13 See Mehrhoff (2014).

14 Note that seasonality in this context refers to “weak seasonality”.

15 In natural logarithms, the model reads: $\ln p_i^{mt} = \ln \pi_i^{mt} + \ln \sigma_i^{mt}$. It is, thus, a structural time series model in the sense of Harvey (1989). The non-seasonal component includes the trend-cycle and irregular component, while the seasonal component also includes calendar effects, e.g. the influence of differences in the dates of public holidays. On the estimation of the seasonal component, see “Estimation of Alternative III” in the Appendix.

ratio between the old and the new seasonal component in December. Moreover, the year-on-year growth rates from January to November of the first year are distorted by the changes in the seasonal pattern for the corresponding months:

$$\frac{\tilde{p}_i^{m,2015}}{p_i^{m,2014}} = \frac{\pi_i^{m,2015} \cdot \sigma'^{m,2015}_i \cdot \frac{\sigma_i^{12,2014}}{\sigma'^{12,2014}_i}}{\pi_i^{m,2014} \cdot \sigma_i^{m,2014}} = \frac{p'^{m,2015}_i \cdot \frac{\sigma_i^{12,2014}}{\sigma'^{12,2014}_i}}{p'^{m,2014}_i \cdot \frac{\sigma_i^{m,2014}}{\sigma'^{m,2014}_i}}$$
$$= \frac{p'^{m,2015}_i}{p'^{m,2014}_i} \cdot \frac{\sigma_i^{12,2014}}{\sigma'^{12,2014}_i} \Big/ \frac{\sigma_i^{m,2014}}{\sigma'^{m,2014}_i}. \qquad (4)$$

Note that the year-on-year growth rate in December is not distorted since the last two terms of equation (4) cancel out, such that:

$$\frac{\tilde{p}_i^{12,2015}}{p_i^{12,2014}} = \frac{p'^{12,2015}_i}{p'^{12,2014}_i} \cdot \frac{\sigma_i^{12,2014}}{\sigma'^{12,2014}_i} \cdot \frac{\sigma'^{12,2014}_i}{\sigma_i^{12,2014}} = \frac{p'^{12,2015}_i}{p'^{12,2014}_i}. \qquad (5)$$

For the annual average rate of change, a distortion can be observed which is approximately as high as the ratio between the old and the new seasonal component in December, reflecting the level shift in the series. Under the (reasonable) assumptions that the change in the seasonal pattern is unrelated to the price levels and the new seasonal pattern is not too volatile, the expected value of the annual average rate in 2015 is given by:

$$\frac{\frac{1}{12}\sum_{m=1}^{12} \tilde{p}_i^{m,2015}}{\frac{1}{12}\sum_{m=1}^{12} p_i^{m,2014}} = \frac{\frac{1}{12}\sum_{m=1}^{12} p'^{m,2015}_i \cdot \frac{\sigma_i^{12,2014}}{\sigma'^{12,2014}_i}}{\frac{1}{12}\sum_{m=1}^{12} \pi_i^{m,2014} \cdot \sigma_i^{m,2014} \cdot \frac{\sigma'^{m,2014}_i}{\sigma'^{m,2014}_i}}$$
$$= \frac{\bar{p}'^{2015}_i \cdot \frac{\sigma_i^{12,2014}}{\sigma'^{12,2014}_i}}{\frac{1}{12}\sum_{m=1}^{12} p'^{m,2014}_i \cdot \frac{\sigma_i^{m,2014}}{\sigma'^{m,2014}_i}} \approx \frac{\bar{p}'^{2015}_i}{\bar{p}'^{2014}_i} \cdot \frac{\sigma_i^{12,2014}}{\sigma'^{12,2014}_i}. \qquad (6)$$

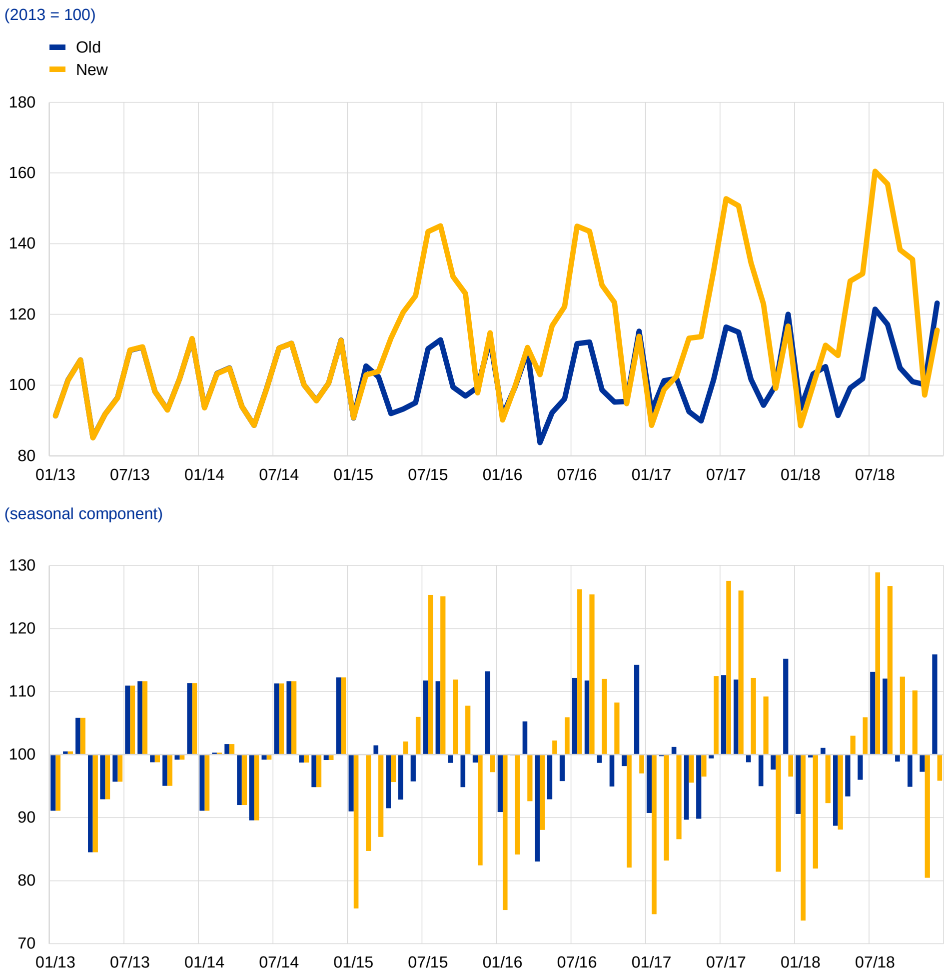
3.2 Selected EU country examples

Empirical examples for European countries are presented below, in which the current chain-linking practice over December has exacerbated a statistical break in the HICP series. The most recent example comes from the HICP release for January 2019, when the HICP subcomponent “package holidays” (European Classification of Individual Consumption according to Purpose (ECOICOP) 09.6) for Germany was revised back to 2015.[16] Due to a change in the compilation practice of the Federal Statistical Office of Germany, the new price index series exhibits a more pronounced seasonal pattern with higher peaks in the summer months and lower values in the winter months (see Chart 1). Specifically, while the old series typically exhibits seasonal peaks in December, with the new seasonal profile, December figures tend to be close to the annual average, as reflected by the seasonal component in Chart 1. In accordance with the chain-linking rules for the HICP, the price relationships were calculated and chain linked to the previous year's December figures. This means that the development of prices in 2015 was measured against December 2014 according to the new method, but the chain linking was done using December 2014 under the old method. Hence, the *one-month overlap technique* led to an upward bias in the monthly year-on-year growth rates from January up to November 2015. Furthermore, the annual average rate for 2015 was upward biased, i.e. 16.5% instead of -0.3%. This is also visible in the post-revision seasonally adjusted series, where the new month-on-month growth rate for January 2015 was 19.8%, instead of -0.7%.

[16] While the previous method used weights at the elementary level that varied according to the summer or winter season, the new approach uses annual weights that are kept fixed over the entire year. See also Eurostat (2019).

Chart 1

German HICP subindex “package holidays” before and revision back to 2015



Source: Federal Statistical Office in Germany.
Note: Seasonal adjustment with JDemetra+.

There are similar examples when changes in December’s seasonal profile led to statistical distortions in the chain-linked HICP series. For instance, the seasonal profile for the HICP subcomponent “package holidays” for Sweden and the HICP subcomponent “accommodation services” (ECOICOP 11.2) for Denmark became more pronounced due to methodological changes, resulting in higher values in the summer months and lower values in the winter months (see left panel of Chart 2). With the inclusion of domestic package holidays in 2017, the Swedish price index series exhibited large seasonal peaks in the summer months and troughs in the winter months. From 2016 onwards, Statistics Denmark reclassified rents on holiday apartments, whose prices are very seasonal, assigning them to the ECOICOP sub-class “accommodation services”. In both country examples, chain linking over December led to upward-biased growth rates. Likewise, problems with chain linking can also occur when the seasonal pattern becomes *weaker*, as illustrated by the case of the German HICP subcomponent “accommodation services” (see right panel of Chart 2). From 2013 onwards, the Federal Statistical Office included smaller service providers in its price collection. Since these are less likely than larger providers to charge seasonal premiums, the resulting price index showed significantly smaller seasonal fluctuations than before.[17] As a result of chain linking the new series over December with a seasonal peak in the old series, the year-on-year growth rate as well as the annual average growth rate for 2013 and the month-on-month growth rate for January 2013 were upward-biased. This statistical bias was the focus of special attention in relation to the ECB Governing Council's economic assessment in 2014, when the then President Mario Draghi referred to it as a "quirk".[18]

There may also be other examples, besides "package holidays" and "accommodation services", where chain linking over December has exacerbated a statistical break in the HICP series. Generally, the bias is aggravated if the old December value strongly deviates from the new December value in terms of seasonal amplitudes.

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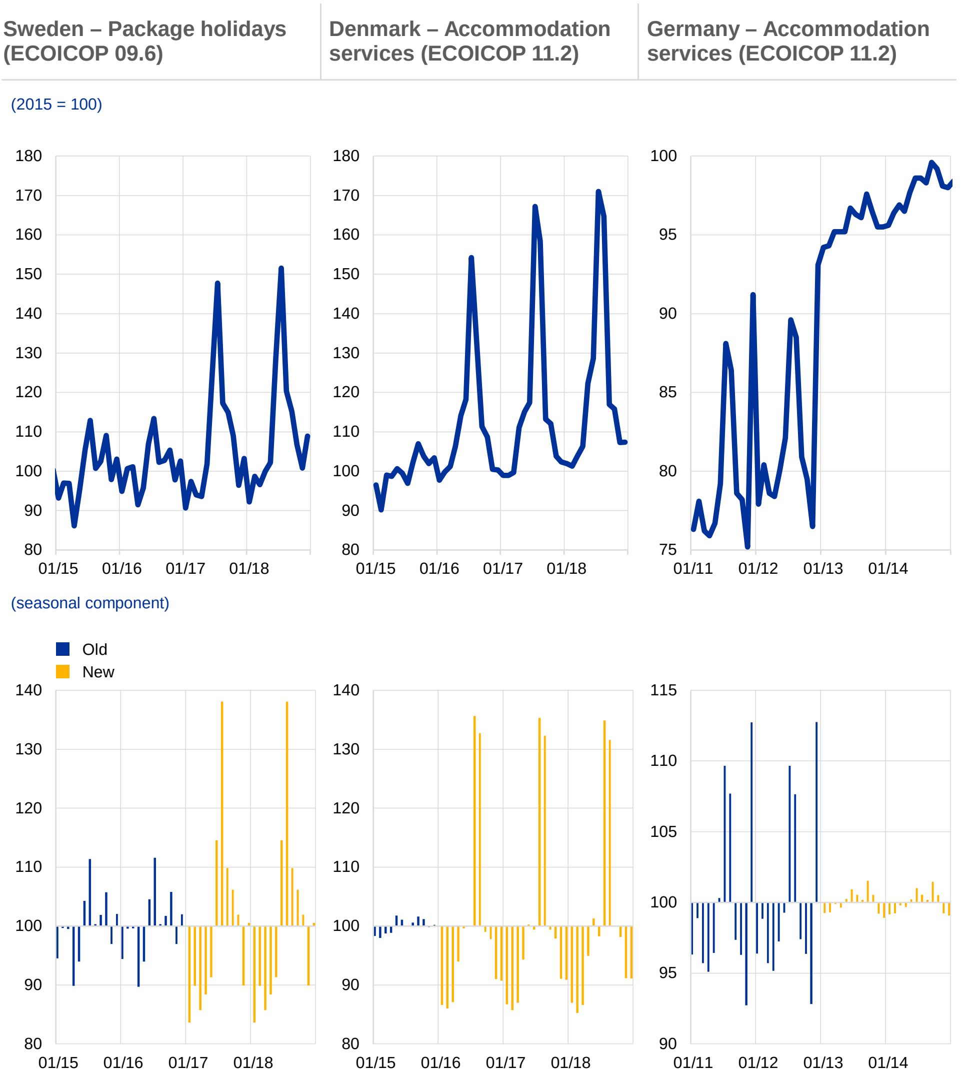
[17] See Deutsche Bundesbank (2013).

[18] In the Q&A session at the ECB press conference on 9 January 2014, President Draghi commented on the recent HICP developments as follows: "The data that came out in December 2013 were essentially the result of a technical issue, what some people would call a quirk, in the statistics on services inflation in Germany".

Chart 2

HICPs with a changing seasonal profile in linking month December



Source: Eurostat.
Note: Seasonal adjustment with JDemetra+.

4 Alterative linking methods and recommendations for data users

This section presents alternative linking methods (Section 4.1), with a direct application to the most recent case of German package holidays in the HICP (Section 4.2). Finally, recommendations for data users on how to deal with such statistical breaks due to chain linking, as well as implications for central bank communication, are discussed (Section 4.3).

4.1 A presentation of alternative linking methods

The examples above suggest that chain linking over December may create serious time series breaks when there are major changes in the HICP methodology. Changes to the linking method could therefore could be considered so that the size of the statistical break is mitigated, while preserving the basic principle laid down in the HICP Framework Regulation of using December as the price reference period. Three alternatives are presented below.

The first alternative relies on revised backdata and uses a *level correction through an overlapping annual average*. This can be done by rescaling the short-term price index P in the overlapping period as follows:

$$CP^{b,mt} = P^{0t,mt} \cdot \frac{\overline{CP}^{b,t}}{\bar{P}^{0t,t}}, \tag{7}$$

where $\overline{CP}$ and $\bar{P}$ are the respective average values in the overlapping year. Since the HICP uses December as the linking month, the chain linking should be performed using a "level shift" during the calendar year:

$$CP^{b,mt} = CP^{b,12(t-1)} \cdot P^{0t,mt} \Big/ \left(\frac{\bar{P}^{0t,t} / P^{0t,12(t-1)}}{\overline{CP}^{b,t} / CP^{b,12(t-1)}} \right), \tag{8}$$

where $P^{0t,12(t-1)} = 1$. The next year $t+1$ would again use the chain link over December without any further adjustment. Note that this procedure requires at least one year of overlapping data for both the old and new method.[19] In the absence of revised backdata, the adjustment factor, as given in equation (8), could also be estimated.[20]

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[19] For instance, the Federal Statistical Office of Germany applies this procedure in its national Consumer Price Index (CPI) for very volatile components, such as package holidays. Moreover, Statistics Netherlands opted for this level-shift approach when changing its methodology for passenger flight transport and package holidays (see Walschots, 2012).

[20] Referring only to the ratio of the year t to December in $t-1$, $\overline{CP}^{b,t} / CP^{b,12(t-1)}$, would neglect possible trends in the short-term series, $\bar{P}^{0t,t}$.

Alternatively, in the absence of any backdata, it would be also possible to link the series *over the previous year's average*, i.e. to apply the growth rates of the new series (with the price reference period in December of the previous year) to the previous year's average. Applying equation (8), this would involve estimating the adjustment factor by using (old) data from a year earlier. This is not true, however, for the short-term trend since this component needs to reflect the new seasonal pattern; in the short-term index, the value for December of the previous year is set to 100. Note that this procedure also differs from the *annual overlap technique* described above, since the latter uses the average year as a price reference period and therefore requires backdata for this year.

Finally, a third alternative consists in *"de-quirking"* the index series.[21] This technique adjusts the series for the base effect stemming from chain linking and for differences in the seasonal profile under the new and old methodology, as reflected in equation (3). By using the relationship between the old and new seasonal factors, all index values prior to the introduction of the methodological change are revised backwards so that the entire index series follows the new seasonal pattern. Hence the monthly rates are revised for the entire old series. The remaining growth rates (annual average rate, the seasonally adjusted monthly rates and the annual rates) are left unchanged (except for rounding errors).[22] A severe drawback is the need for estimation of the new and the old seasonal profiles. For a backward calculation of the new seasonal profile, at least 12 monthly observations of the new price index are necessary, meaning that the NSI needs to provide one year of parallel calculations, for the new and old methodology.[23] Furthermore, the seasonal component is prone to revisions, with re-estimations including new observations. This leads to revisions of the entire old series when new observations are taken into consideration.

4.2 Applying alternative linking methods to the case of German package holidays

Table 2 shows all three alternative linking methods applied to the case of German package holidays, where revised backdata from 2015 onwards was published with the January 2019 HICP release.

Based on equation (8), the German figures with the index reference period $b = 2015$ yield in the overlapping year 2015:

$$CP^{b,mt} = CP^{b,12(t-1)} \cdot P^{0t,mt} / \left(\frac{104.6/100.0}{100.0/111.7} \right), \tag{9}$$

21 See Mehrhoff (2014).

22 Alternatively, the HICP series could also be "seasonalised forward" by using the old seasonal profile for the period following the introduction of the methodological change. The resulting annual average rates are unaffected by this choice.

23 From the perspective of seasonal adjustment, 36 months would be necessary to estimate the seasonal component properly.

i.e. an adjustment divisor of 1.168 between the old and the new series in the year 2015. However, the case of German HICP package holidays is even simpler: for both the old and new official index series, the year 2015 is the index reference period which equals 100. Therefore, the two series can be combined without any changes in the respective index values by simply concatenating the new official index into the old index in January 2015. In Table 3, this approach is labelled *Alternative I*, which leaves the annual average growth rate in 2015 unchanged. Nevertheless, this approach comes at the cost of a biased month-on-month rate of change in January 2015 as against December 2014.

Alternative II consists in chain linking over the annual average of the previous year (i.e. 2014), while still using December 2014 of the new series as the price reference period. This approach does not require any backdata, but it also comes at the cost of a biased month-on-month rate of change in January 2015. Moreover, there would still be an upward bias in the annual average rate for 2015, although this would be less pronounced than in the post-revision series.

"De-quirking" the German package holidays series, as described in the previous paragraph, would yield *Alternative III*, which keeps all rates of change unbiased. However, this procedure revises the index numbers from November 2014 back to the early beginning of the series using estimated seasonal profiles and thus needs a relatively long period of backdata.

Nevertheless, these three alternatives mitigate the problem of a statistical bias due to chain linking in comparison with the standard HICP practice of December overlaps, since they control for the level shift due to a new seasonal profile (see Chart 3).

Table 2

Revision of German HICP package holidays and alternative linking methods

(annual average rate of change in the of HICP subindex 09.6)

Period	Pre-revision series	Post-revision series Chain linking over December 2014	Alternative I Level correction by 2015 overlap	Alternative II Level correction by 2014 average	Alternative III "de-quirking" (old series follows new seasonal profile)
2014	1.2	1.2	1.2	1.2	1.2
2015	-0.3	16.5	-0.3	4.6	-0.3
2016	-0.8	-1.6	-1.6	-1.6	-1.6

Sources: Federal Statistical Office in Germany, own calculations.

Table 3

Properties of alternative linking methods

(annual average rate of change in the of HICP subindex 09.6)

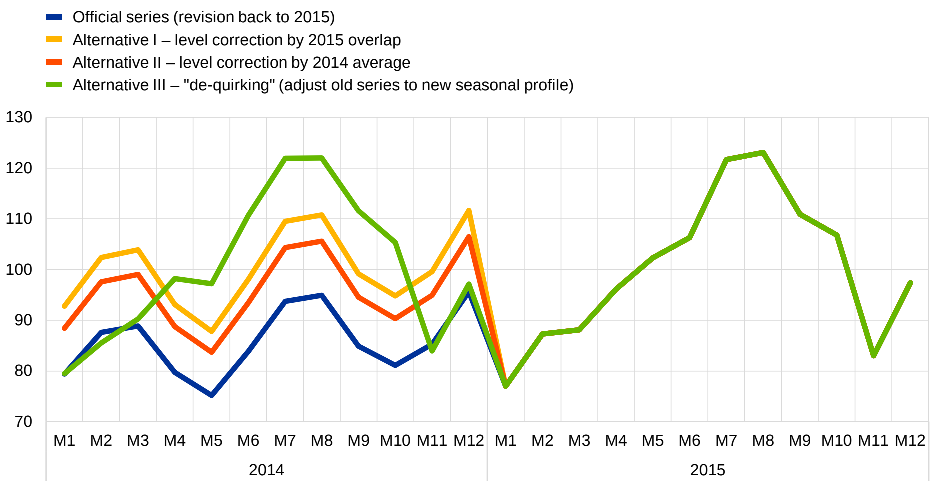
Period	Post-revision series Chain linking over December 2014	Alternative I Level correction by 2015 overlap	Alternative II Level correction by 2014 average	Alternative III "de-quirking" (old series follows new seasonal profile)
Annual average rate	**Bias in 2015**	**Unbiased**	**Bias in 2015**	**Unbiased**
Month-on-month rate	**Unbiased***	**Bias in Jan. 2015**	**Bias in Jan. 2015**	**Unbiased****
Year-on-year rate	**Bias in 2015**	**Bias in 2015**	**Bias in 2015**	**Unbiased**
Data requirements	One month of parallel calculation (December 2014)	One full year of parallel calculation (2015)	One month of parallel calculation (December 2014)	At least one year of parallel calculation to estimate new seasonal profile
Implication for data production	Follows HICP standard practice	One-time adaption for given subindex	One-time adaption for given subindex	Entire HICP subindex (and higher-level aggregates) revised backwards

Notes: * Biased in January 2015 after seasonal adjustment. ** After seasonal adjustment.

Chart 3

Alternative linking methods for German HICP package holidays

(2015 = 100)



Source: Eurostat and Deutsche Bundesbank calculations.

4.3 Recommendations for data users and central bank communication

When analysing movements in the HICP, data users should be aware of statistical distortions and may apply the alternative linking techniques presented above in order to mitigate these distortions. For example, concerning the revisions of the German HICP for package holidays (ECOICOP 09.6), a time series for this HICP item could be created using *Alternative I* (i.e. concatenating the new official index series into the old one in January 2015). Then, higher aggregate index series, such as the HICP excluding food and energy, could be compiled applying the standard HICP chain-linking approach, using this time series as an element. When focusing on annual growth rates rather than index values only, another simple approach would be to use annual rates of change up to December 2015 based on the index before the methodological change, and to use annual growth rates derived from the index calculated by applying the new method from January 2016.[24]

More sophisticated treatments may use techniques from time series analysis, e.g. outlier adjustment. Such practices applied by data users on a case-by-case basis may make it possible adjust for a statistical distortion to best meet the user's purpose. For example, the revision could be pushed into a single month-on-month change at the breakpoint, e.g. January 2015 in the case of German package holidays. However, two issues need to be considered in econometric models. First, the outlier needs appropriate modelling to prevent distortion of the coefficient estimates, e.g. using dummy variables. Second, due to the new seasonal profile, the short-term dynamics of the time series will be different, which has to be modelled too.

As regards external communication, it is recommended that the relevant time series be flagged in the database and additional explanatory notes be provided when commenting on such breaks. Where the impact is significant, expert users may be inclined to compile their own break-adjusted time series. While the community of users would benefit from providing such adjusted time series to the public at large, the existence of parallel HICPs, e.g. one version being adjusted for breaks and the other not, complicates the communication of policy-related subjects substantially. These issues could be overcome if methodological changes were also incorporated into back data of official statistics. This might require estimations. Furthermore, compilers of official statistics have to strike a balance between the accuracy of backdata estimations and the provision of break-free series. With regard to EU statistics, Eurostat might consider providing guidelines for such back estimations.

[24] See ECB (2019). Moreover, Statistics Netherlands introduced this approach for data users when revising its HICP methodology in 2013 (see Walschots, 2012).

5 Conclusion

This paper has presented several cases of methodological changes in HICPs in which the current chain-linking technique has led to significant distortions of annual rates of change; it has also suggested possible solutions for users who employ these data intensively, such as central banks. Nevertheless, it is of key importance that official statistics treat statistical distortions arising from the introduction of new statistical methods in a way that ensures that adverse impacts on data usage are kept as small as possible. Policy-related analyses, forecasts and decisions place particular emphasis on the use of official statistics due to their independent, objective, transparent compilation in line with internationally acknowledged statistical standards. Individual treatments applied by data users to meet particular user needs cannot serve as a substitute in this regard.

Statistical distortions arising from the current HICP chain-linking technique might also be exacerbated by the introduction of new digital data sources, such as web scraping and scanner data. More and more NSIs already use, or are in the process of incorporating, these kinds of new data into the regular HICP production process. This major methodological change in price compilation also points to a need for a more flexible application of chain linking in justified cases in the future. Drawing up guidelines on how such cases should be dealt with by the European Statistical System, recommending the concrete application of an appropriate chain-linking technique when new seasonal profiles or one-off effects in December become significant, could assist with this approach.

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Appendices

Appendix 1: Estimation of Alternative III ("de-quirking" a time series)

"De-quirking" a time series relies on estimates of the seasonal components of both the old and the new series in the year prior to the change in methodology, i.e. an overlap in the calculation of the two series before the introduction of the new methodology is needed.[25] To this end, filter and model-based approaches are commonly employed.[26]

Given the estimates of the seasonal components and the assumption that the non-seasonal component remains unaffected by the change in methodology, the time series can be "de-quirked" as follows.

For a methodological break occurring in 2015, we would adjust the 2014 data – from *January to November* – of the old series. From equation (4), we know that the year-on-year growth rates for 2015 are distorted by the factor:

$$\frac{\sigma_i^{12,2014}}{{\sigma'}_i^{12,2014}} \Big/ \frac{\sigma_i^{m,2014}}{{\sigma'}_i^{m,2014}}.$$

There are two effects at play. First, the new series $\tilde{p}_i^{m,2015}$ is shifted upward if $\sigma_i^{12,2014} > {\sigma'}_i^{12,2014}$ and vice versa; this needs to be applied mutatis mutandis to the old series as well. Second, the monthly seasonal profile from the new method needs to be imputed, very much as it is in done in quality adjustment, using price-determining characteristics. Hence, if we multiply the 2014 data by this factor, the bias vanishes:[27]

$$\tilde{p}_i^{m,2014} = p_i^{m,2014} \cdot \frac{\sigma_i^{12,2014}}{{\sigma'}_i^{12,2014}} \Big/ \frac{\sigma_i^{m,2014}}{{\sigma'}_i^{m,2014}}.$$

A long time series can be constructed by calculating backwards years prior to 2014 using the unbiased year-on-year growth rates from the old (unadjusted) series, e.g. for 2013:

$$\tilde{p}_i^{m,2013} = \frac{\tilde{p}_i^{m,2014}}{p_i^{m,2014} / p_i^{m,2013}}.$$

25 Alternatively, the "de-quirking" could also be performed "forwards", where estimates of both seasonal components in the year following the changeover would be required. Unless the change in methodology is introduced by a backward revision, it is unlikely that this information will exist since the old series is probably discontinued.

26 While the seasonal component is frequently estimated for the purpose of seasonal adjustment, this is not a concern here. For an introduction to filter-based approaches, see Ladiray and Quenneville (2001). Model-based approached were developed by Burman (1980) and Hillmer and Tiao (1982). Since these approaches rely on time averaging, the decomposition is subject to revisions.

27 The example for German package holidays is special insofar as the backward revision went back as far as the first observation of the new series in January 2015. In this rather exceptional case – particularly since the HICP is not typically revised backwards (see footnote 25) – there is, therefore, no estimate for the seasonal component in the months of 2014. Since seasonal fluctuations recur with similar intensity in the same season each year, and for the sake of exposition, the "de-quirking" was performed on the basis of estimates of the seasonal components for 2015.

Appendix 2: Examples of statistical distortions in the HICP due to the current chain-linking practice

First month of statistical break	Country	HICP component (ECOICOP)	Comment
January 2013	Germany	Accommodation services (11.2)	Sample extended to small service providers which do not charge a seasonal premium
January 2015	Germany	Package holidays (09.6)	With the January 2019 HICP release, revision of HICP series back to January 2015
January 2016	Denmark	Accommodation services (11.2)	Holiday apartments re-classified as accommodation services
January 2017	Sweden	Package holidays (09.6)	Sample extended to domestic package holidays

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