The impact of weight shifts on inflation: Evidence for the euro area HICP*

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Abstract

The shifts in household consumption caused by the coronavirus pandemic affect inflation measurement in the euro area via the updating of product weights. We propose a decomposition of the inflation rate, measured by the annual percentage change of the Harmonised Index of Consumer Prices (HICP), into the aggregate price change, keeping weights constant at the previous year's level, and a weighting component. We discuss this decomposition against the backdrop of the HICP concept, considering the evolution of measurement rules over time and marking differences to a decomposition into pure price change and quantity components. Our empirical results show that euro area inflation was distinctly influenced by weighting effects for the first time in 2021. This can equally be observed for France and Italy, while comparable weighting effects in Germany already occurred prior to 2021, albeit rarely. For the period from 2013 onwards, we also provide results for the quantity effect in HICP inflation of these countries. The empirical evidence shows a close relationship between weighting and quantity effects. As weighting effects can be calculated directly from publicly available HICP data over its entire history and are comparable across individual euro area countries, we argue that this decomposition is relevant in terms of providing timely information, especially for analysts and policy-makers.

Keywords: Inflation measurement · HICP · Updating of weights

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1 Introduction

The coronavirus (COVID-19) pandemic has renewed interest in the formation of weights underlying consumer price indices (CPIs). Designed to describe aggregate price development, CPIs are based on a basket of goods and services which is deemed to be representative of households' consumption patterns. The pandemic has considerably affected consumption patterns because of changes in income and prices and, above all, the temporary unavailability of some goods and services. For instance, while households spent more on food and other groceries, their travel and recreation expenses decreased considerably.

In such an extraordinary situation, there was a broad spectrum of expectations about what inflation figures should measure. In the course of 2020, when measurement rules and established practices prevented statistical offices from immediately considering these shifts in the compilation of official indices, several attempts – even by statistical offices – were made to construct experimental indices building on real-time consumption structures (e.g. Cavallo, 2020, for the U.S.; Kouvavas *et al.*, 2020, for the euro area; ONS, 2020, for the U.K.; Insee, 2020, for France). Advocates of swift weight adjustments interpret the difference between the experimental and official indices as mismeasurement due to an outdated consumption basket. Later, when statistical offices indeed adjusted weighting schemes to capture pandemic-induced shifts in consumption patterns, analysts who expect inflation to represent pure price changes criticised official inflation figures as being severely distorted (Deutsche Bundesbank, 2021).[1] The variety of statistical approaches and the user responses to them reflect the fact that, in general, there is no optimal solution for dealing with significant changes of expenditure shares in inflation measurement.

This paper focuses on measuring the impact of changing weights on inflation and its empirical relevance in terms of the Harmonised Index of Consumer Prices (HICP). In particular, we present a way to isolate the effect in the inflation rate, measured by the year-on-year HICP percentage change. Other distortions or biases resulting from the fact that economies faced lockdown conditions, such as the temporary unavailability of products and services, are not studied here (see Diewert and Fox, 2022, for an extensive discussion). In this paper, we also refrain from discussing the derivation of intra-annual weights and its reliability.

The HICP, used to measure price stability and thus guide monetary policy in the euro area, is a cost-of-goods index (COGI). It is designed to measure "the changing cost of a *fixed basket of products* at different sets of prices over time" (Eurostat, 2018, p. 22; italics in original). In measurement practice, it is a Laspeyres-type index where the weights representing the expenditure pattern of the previous year ("weight reference period") are kept constant within a calendar year. From year to year, weights are updated and

[1] According to Eurostat (2020, 2021), HICP weights for 2021 and 2022 were derived using a best-guess approach, making use of preliminary national accounts data for the previous year as well as other available data sources.

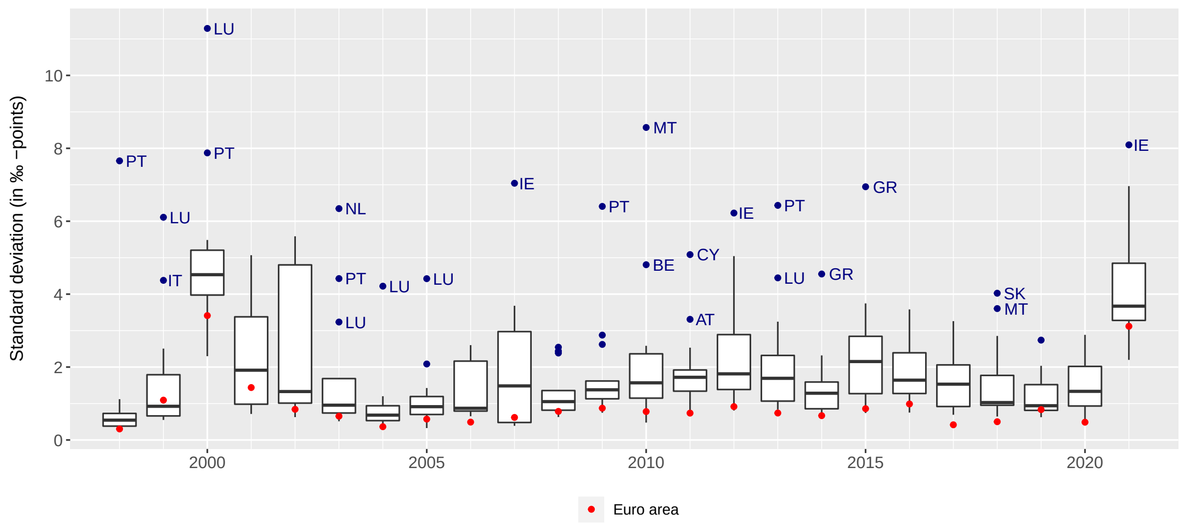


Figure 1: Standard deviation of annual weight changes in HICPs of euro area countries.

price indices are chain-linked over December ("price reference period").[2] The considerable shifts in the 2021 HICP weights due to the COVID-19 crisis and their effect on inflation measurement have attracted attention from monetary policymakers in the euro area (e.g. Gonçalves *et al.*, 2021; Deutsche Bundesbank, 2021).

The weight changes of the 76 product categories varied in the euro area HICP from 2020 to 2021 by a standard deviation of 3.12 per mille points (Fig. 1). This has been the largest variability since 2000, when weights had shifted strongly as a result of a statistical break, namely a considerable extension and harmonisation of HICP coverage (European Central Bank, 2000, Box 3). In the remaining years, euro area HICP weights varied to a small extent. The boxplots displayed in Fig. 1 indicate that the 2000 and 2021 peaks seem to be a common feature of weight changes in all national HICPs of the euro area. However, outliers occur over the whole graph and pertain to a multitude of countries, suggesting that HICP weight variability may be non-systematic across euro area countries to a large degree. In particular, some smaller countries such as Luxembourg, Malta, Ireland and Portugal experienced very high weight variability in specific years.

In this paper, we propose a metric which measures the effect of changing weights on the year-on-year HICP inflation rate. In particular, we derive a decomposition of inflation into the aggregate price change, assuming HICP weights are kept constant, and a weighting component. In the methodological part, we make clear that this decomposition is worth looking at from a practioner's point of view, though it deviates conceptually from a decomposition of the year-on-year HICP rate which disentangles the "pure" price changes

[2] The COGI concept – in its well-defined HICP specification as a Laspeyres-type index with strict weight updating rules – only makes it possible to pin down the effect of changing consumption patterns on inflation using the approach developed here. By contrast, a cost-of-living index (COLI), whose change measures the difference in minimum expenditures paid by a household to achieve the same utility level in two periods (Konüs, 1939), generally implies varying expenditure shares. From a conceptual point of view, however, it may be regarded as less meaningful to extract this effect from a COLI inflation measure.

from the effect of changing quantities in the consumer basket (henceforth called quantity effect). While the latter decomposition appears to be the natural choice, starting from the idea that price indices are constructed to separate out the "price part" from a value index (e.g. ILO *et al.*, 2004, pp. 264-265), the main reason for opting for the former is that it provides coherent empirical evidence over the full HICP history, allowing for comparisons across euro area countries and over time. Our focus is thus not only on the impact of weight changes during the COVID-19 pandemic. Rather, we also take the long-run perspective, aiming at assessing its relevance vis-à-vis the aggregate effect of price changes. This may inform monetary policymakers in the euro area about the size and timing of weighting effects in HICP inflation.

Our main conclusions are the following. First, HICP inflation is generally very close to the aggregate price change using constant weights. This is evidenced especially for the euro area, where weighting components are found to be almost always marginal. In individual euro area countries, however, inflation rates might be affected by weight shifts to a recognisable extent from time to time. Second, the COVID-19 crisis has induced weight adjustments, meaning that euro area inflation may be regarded as being distorted by weighting effects of up to 0.5 percentage points (pp) in absolute terms during the summer months of 2021. In some euro area countries, substantial weighting effects were also observed at the beginning of the year with the opposite sign and, in the summer months, they reached an even higher (absolute) magnitude. Third, the weighting effect which builds on shifts in official HICP weights from one calendar year to another tends to closely approximate quantity effects.

Several works on quantifying the contributions of individual product groups to the inflation rate can be found in the existing literature (e.g. Balk, 2018; de Haan and Akem, 2017; Walschots, 2016). In the context of HICP measurement, one prominent approach is that known as the Ribe decomposition (see Eurostat, 2018, pp. 180-181). Although the initial idea of these techniques is similar to ours, they do not aim at disentangling the aggregate impact of changing weights on annual inflation. One recent exception can be found in European Central Bank (2021, Box 6). The formal decomposition of the inflation rate, however, deviates from our approach.[3] In addition, our paper embeds this aspect of HICP measurement more into index number theory. A further decomposition can be found in Diewert (2021, pp. 29-33) who theoretically derives an aggregate measure of the impact of quantity weight changes on HICP inflation. His approach is similar to our decomposition into pure price change and quantity effects, but is based on the use of actual quantities or at least quantity indices, whereas our calculations rely on publicly available data. Moreover, we enrich our decomposition with empirical evidence for the euro area and three euro area countries.

[3] The inflation rate is decomposed in European Central Bank (2021, Box 6) into three components: a fixed-weight Laspeyres change rate from month m to December of year $y-1$, as well as a price change and a combined price weight change from December of year $y-1$ to month m of the current year y, respectively. The latter two components are multiplied by a scaling factor.

The remainder of the paper is set out as follows. In Section 2, we outline a methodological discussion of fixed-basket versus chain indices in the context of HICP measurement, which has occasionally flared up over the past 20 years. In Section 3, we lay down the methodological framework and derive the decompositions of HICP inflation into price change and weighting components as well as pure price change and quantity components. In Section 4, we present the empirical results for the HICP of the euro area and euro area countries with a focus on both the long-run view and the COVID-19 phase. The final Section 5 draws conclusions.

2 Weight changes and their relevance for HICP measurement and interpretation

In the concept underlying the HICP, inflation is intended to measure the change in the total amount of money which has to be paid for a fixed bundle of goods and services at two points in time (i.e. "pure" price change). Quantity effects are therefore conceptually excluded. The purpose is to measure the total and exclusive contribution of individual price movements to a change in a value index.[4] In measurement practice, however, inflation is sometimes affected by changing quantities because the basket of goods and services is adjusted from time to time in order to keep it representative.[5] Due to those basket-related effects, inflation does not always and exclusively reflect pure price changes.

According to the HICP Framework Regulation (European Union, 2016), the HICP is a chained Laspeyres-type index which is defined by

$$P^{0,t} = \sum_{i=1}^{I} \frac{p_i^t}{p_i^0} \, w_i^{0,b} \; , \tag{1}$$

where p_i^0 and p_i^t are the prices of good i ($i = 1, \ldots, I$) in the current period t and the price reference period 0. The weight $w_i^{0,b}$ reflects the expenditure share of good i in period b prior to the price reference period but which is "adjusted to reflect the prices of the price reference period" (European Union, 2016, Art. 2 (14)). From an index theoretical perspective, Eq. (1) can also be seen as a Lowe index (e.g. ILO *et al.*, 2004, pp. 2-3).

This definition lacks rigour with regard to weight compilation. This was intended from the outset because Eurostat and the National Statistical Institutes (NSIs) were forced to

[4] Von der Lippe (2001, Section 8.2) proposes three conceptualisations of the idea of pure price comparisons. Most generally, he claims that only prices are allowed to vary in a price index ("one influence factor" or "ceteris paribus-concept"). As this does not exclude index formulas without any weighting, two additional criteria are imposed. The price index should have constant weights for all periods and it should be linear in the prices of the current period. These conditions are met by the bilateral Laspeyres index.

[5] According to von der Lippe (2001, pp. 18-20), the multi-year adjustment of weights may be regarded as a compromise between the representativity principle and the principle of pure price comparison. See Leifer (2002, Fn. 17) for a similar argument.

"find a compromise between 'fixed' and 'chained' indices" (Astin and Sellwood, 1997, p. 7) in order to create a harmonised index that guides monetary policy in the euro area. In particular, the European Commission Regulation (European Commission, 1997) prescribed only minimum standards, namely that HICP weights had to refer to a 12-month period not more than seven years prior to December of the year $t-1$ which, for instance, allowed use to be made of results which are derived from quinquennial Household Budget Surveys (HBS) with a two-year lag. Eiglsperger and Schackis (2009, p. 4) concluded that the minimum standards "allow[ed] compiling national HICPs either as annually chained indices or as direct price indices whose quantities are fixed for some years."

In the euro area, the "fixed-basket camp" consisted of Belgium, Germany, Ireland, Greece, Cyprus, Malta, Austria and Finland. The underlying basket of goods was updated at three to five-year intervals. HICP weights were annually adjusted by price-updating expenditure shares, i.e. $w_i^{0,b} = (p_i^0/p_i^b)\,w_i^b$ and $w_i^b = p_i^b\,q_i^b/\sum_{j=1}^{I} p_j^b\,q_j^b$, where q_i^b is the quantity of good i in year b, i.e. when the HBS was conducted ("base year"). This is equivalent to a Laspeyres price index (P_L) where the basket of goods and services is fixed from one HBS wave to another. The price index formula (1) can be transformed from its representation as a mean of price relatives into a ratio of expenditures (measuring the changing costs of a fixed basket):

$$P^{0,t} = \sum_{i=1}^{I} \frac{p_i^t}{p_i^b}\, w_i^b = \frac{\sum\limits_{i=1}^{I} p_i^t \cdot q_i^b}{\sum\limits_{i=1}^{I} p_i^b \cdot q_i^b} \equiv P_L^{b,t}\,.$$

The remaining euro area countries belonged to the "chain index camp", interpreting Eq. (1) as being consistent with a price index in the tradition of Divisia's (1926) theoretical index formula. An approximation to the continuous-time formula was derived from totally differentiating the value aggregate through time yields Eq. (1) with $w_i^{b,0} = w_i^0$ (Forsyth and Fowler, 1981; ILO *et al.*, 2004, pp. 278-280). In this interpretation, the HICP results from chaining price indices compiled according to Eq. (1) within each calendar year, where expenditure shares are "calculated afresh for each link in the chain index" (Forsyth, 1978, p. 352). In contrast to the fixed-basket approach, weight updates are not limited to a specific rule; they should instead reflect that "expenditure patterns change continuously because of changes in incomes, tastes and technology and an assumption of an unchanged consumption pattern can only be acceptable for index comparisons over quite short periods" (Forsyth, 1978, p. 349).

From 2012 onwards, HICP weights are required to be annually updated in order to make them representative for the weight reference period (e.g. European Central Bank, 2012, Box 3). Thus, the latest release of national accounts is regarded as the most relevant source. These tighter quality standards for weights were welcomed because they might "significantly improve the comparability of the HICP across countries as well as the relevance and reliability of the HICP" (Eiglsperger and Schackis, 2009, p. 5).[6] In methodological terms, this harmonisation step tipped the balance towards the "chain index camp". For all countries, the HICP has since been a fixed-basket price index only in comparisons within the same calendar year, whereas the year-on-year percentage changes of all months but December have been systematically affected by quantity effects.

While the fixed-basket versus chain index debate had been rather controversial in the run-up to the HICP and in its early years,[7] the implementation of the crucial step in 2012 did not trigger a lively discussion, with Eiglsperger and Schackis (2009) worth mentioning as an exception. In addition, the methodological change was apparently enacted without major attempts to assess the empirical relevance of weight changes for the year-on-year rates. European price statisticians seem to have developed measurement principles under the dogma, or with reference to unpublished Eurostat studies,[8] that "consumer price indices are fairly insensitive to changes in weights" (Astin and Sellwood, 1997, p. 6).[9]

In recent years, monetary policymakers have become more and more aware of the possibility that weight updates may impact the year-on-year HICP change rate to a recognisable extent under specific circumstances. An example is the 2019 methodological change in the sampling of package holiday prices, which induced the weight adjustment of this price component in that year to heavily affect the German HICP rates (Deutsche Bundesbank, 2019). The COVID-19 crisis has led to considerable shifts in expenditure patterns. Eurostat (2020) provided guidance for weight updating practice in these extraordinary times. With its special bearing on private consumption in the crisis and normalisation phase, this seminal event is definitely a stress test for the HICP compilation principles currently in use.

[6] In addition, the annual updating was considered advantageous, as it was expected to further reduce the representativity bias. Indeed, Herzberg *et al.* (2021) find for the euro area and Germany that the HICP has been subject to a smaller positive representativity bias since 2012 than from 1997 to 2011. In this paper, however, it is argued that the annual updating has to rely on provisional national accounts (instead of revised or final data), inducing a data vintage effect which may impair the accuracy of the HICP as a measure of "true" inflation.

[7] Chaining was – sometimes rather heavily – criticised by some German price statisticians, for instance. See von der Lippe (1999, 2000, 2001) and Leifer (2002).

[8] The Eurostat studies are simply mentioned by Eiglsperger and Schackis (2009, p. 9) without going into their content.

[9] The paragraph on weight compilation in Astin and Sellwood (1997) leads us to conclude that, in the early days of the HICP, Eurostat seemed to be more concerned about the non-comparability of weights across countries (owing to belated, less frequent and/or non-coordinated updating) rather than potential adverse repercussions of weight shifts on price indices or inflation. In a purely semantical sense, Astin and Sellwood's statement might be correct, as it refers to the elasticity of weight shifts on price indices. What matters in this context, however, is not the elasticity but the response. The COVID-19 crisis has shown that, under extraordinary circumstances, the impulse in terms of large weight shifts might be big enough to induce recognisable responses to inflation.

3 Methodology

In the first part of this section, we propose a formal decomposition of the year-on-year HICP percentage change into a price change component and a weighting component. The latter quantifies the total impact (in pp) of the change in HICP weights of all price components from one year to another on the inflation rate. In the second part, we differentiate this decomposition by removing the quantity component from the inflation rate, which allows the remaining component to be interpreted as pure price changes in a COGI sense.

The inflation rate $\pi^{y|m}$, measured by the year-on-year HICP percentage change rate, in year y and month m ($m = 1, \ldots, 12$) can be expressed by

$$\pi^{y|m} = \frac{P^{y|m}}{P^{y-1|m}} - 1\,, \tag{2}$$

where $P^{y|m}$ represents the HICP index value in month m of year y. In Appendix A, it is shown that $\pi^{y|12}$ solely relies on a single set of weights, which is why any weighting or quantity effects are absent in December.[10] For the remaining months $m = 1, \ldots, 11$, however, it is shown that Eq. (2) can be decomposed into

$$\pi^{y|m} = \gamma^{y|m} \cdot \left(\sum_{i=1}^{N} \frac{p_i^{y|m}}{p_i^{y-1|12}} \left(w_i^{y-1} - x_i \right) + \sum_{i=1}^{N} \frac{p_i^{y|m}}{p_i^{y-1|12}}\, x_i \right) - 1\,, \tag{3}$$

where $p_i^{y|m}$ is the price of product i in month m of year y. w_i^{y-1} denotes the weight of product i applied to HICP compilation in calendar year y.[11] $\gamma^{y|m} = P^{y-1|12}/P^{y-1|m}$ is a scaling factor, defined as the ratio of the HICP index values of December and month m in year $y-1$. x_i serves for now as a place holder.

Price change and weighting components in HICP inflation. In Appendix A, it is shown that weighting effects are caused by changes between the weights w_i^{y-1} and w_i^{y-2}. Replacing x_i in Eq. (3) with w_i^{y-2}, the weight of product i applied to the HICP compilation in year $y-1$, results in a decomposition of inflation rate $\pi^{y|m}$ into a price change component, $\lambda^{y|m}$, and a weighting component, $\kappa^{y|m}$:

$$\pi^{y|m} = \lambda^{y|m} + \kappa^{y|m}\,. \tag{4}$$

[10] Strictly speaking, $\pi^{y|12}$ is defined as a weighted sum of price relatives between month m of the current year y and December of the previous year.

[11] Owing to the price update to December, the weight should be written as $w_i^{y-1|12}$ in precise terms. However, we set $w_i^{y-1} \equiv w_i^{y-1|12}$ for notational convenience.

- **Price change component:**

$$\lambda^{y|m} = \begin{cases} \gamma^{y|m} \cdot \sum_{i=1}^{N} \frac{p_i^{y|m}}{p_i^{y-1|12}} \, w_i^{y-2} - 1 & \text{if } m = 1, \ldots, 11 \\ \\ \pi^{y|12} & \text{if } m = 12 \end{cases} \tag{5}$$

The price change component $\lambda^{y|m}$ measures the aggregate price change under the assumption that weights are kept constant at expenditure patterns from two years prior. This points to a conceptual relationship to price measurement using what are known as Young indices (ILO *et al.*, 2004, p. 5). Indeed, Eq. (5) may be rewritten as

$$\lambda^{y|m} = \delta^{y} \cdot \frac{\sum_{i=1}^{N} \frac{p_i^{y|m}}{p_i^{y-1|12}} \, w_i^{y-2}}{\sum_{i=1}^{N} \frac{p_i^{y-1|m}}{p_i^{y-2|12}} \, w_i^{y-2}} - 1$$

for months $m = 1, \ldots, 11$. The key element of the price component is a ratio between the current-year and the previous-year "Young-type" indices for month m.[12] δ^{y} is a chaining factor which is constant within a calendar year.

- **Weighting component:**

$$\kappa^{y|m} = \begin{cases} \gamma^{y|m} \cdot \sum_{i=1}^{N} \frac{p_i^{y|m}}{p_i^{y-1|12}} \left(w_i^{y-1} - w_i^{y-2} \right) & \text{if } m = 1, \ldots, 11 \\ \\ 0 & \text{if } m = 12 \end{cases} \tag{6}$$

The weighting component $\kappa^{y|m}$ provides a measure of the total impact of weight changes on the inflation rate. Abstracting from the scaling factor, $\gamma^{y|m}$, it is a weighted average of weight changes over all products from $y-2$ to $y-1$, where the weights are given by the price ratios between the reporting period $(y|m)$ and the price reference period $(y-1|12)$. The sign of an individual contribution is determined solely by the change in the weight of product i. Hence, the sign does not change within a calendar year. The (absolute) size of an individual contribution also depends on the monthly price ratio, implying that it may fluctuate from one month to another.

From Eq. (5) and (6), it is worth noting that the decomposition refers only to the "partial movement" of prices during the current year (i.e. from December of the previous year to the reference month m). The intuition behind this is that the weighting component "corrects" the inflation rate for the impact resulting from a change in the weighting of

[12] By analogy with the term "Laspeyres-type" used for the HICP because of the price-updating, we regard these indices as being merely a Young type, as w_i^{y-2} are hybrid shares valuing the average quantities of the year $y-2$ with December prices of that year. A Young index is generally defined as a weighted average of price relatives where weights represent true expenditure shares of the weight reference period.

products at the turn of the year.[13]

Pure price change and quantity components in HICP inflation. Removing the weighting effect from the year-on-year rate yields the aggregate price change under the assumption that HICP weights are kept constant at the previous year's levels. This is different from a pure price change in a COGI sense. As detailed in the previous section, a fixed-basket price index is characterised by annually price-updated expenditure shares when written as a chain index formula. As these weight shifts reflect price-induced movements rather than changes in quantities, it is clear that – with the assumption of constant expenditure shares – the price change component in Eq. (5) does not encompass the effects stemming from the entirety of individual price changes.

Including the price changes within the expenditure changes in the price component leads to a pure price change in a COGI sense. Subtracting the pure price change from the year-on-year HICP rate results in a quantity component. Consequently, the price changes within the expenditure changes also represent the difference between the quantity and the weighting component. In formal terms, the quantity component differs from the weighting component by using one-year-ahead price-updated weights from two years prior instead of the published HICP weights of the previous year. This means that the calculation of a quantity effect requires the introduction of an additional weighting scheme where

$$\widetilde{w}_i^{y-1} = \frac{\frac{p_i^{y-1|12}}{p_i^{y-2-\iota}} \left(p_i^{y-2-\iota} \; q_i^{y-2-\iota}\right)}{\sum_{j=1}^{N} \frac{p_j^{y-1|12}}{p_j^{y-2-\iota}} \left(p_j^{y-2-\iota} \; q_j^{y-2-\iota}\right)} \quad \text{with } \iota = \begin{cases} 1 & \text{if } 2012 \leq y \leq 2020 \\ 0 & \text{if } y = 2021 \end{cases} \tag{7}$$

is the weight of product i. Parameter ι serves for case distinction in the derivation of weights, which is explained in the following.

Weights have had to be updated annually according to HICP measurement rules since 2012. Until 2020, statistical offices used national accounts data from two years prior, where the price update from $y-2$ to $y-1$ was optional.[14] As far as we are aware, the three euro area countries under review (Germany, France and Italy) applied the price-updating and, thus, quantity effects reflect the quantity changes in the basket of goods with a lag of one year, i.e. $\iota = 1$ in Eq. (7).[15] As the option of not price-updating is not

[13] Compared to the Ribe decomposition (Eurostat, 2018), the scaling factor $\gamma^{y|m}$ in Eq. (3) could be interpreted as the *last-year term*, which is fixed across products in this case. Consequently, only the *this-year term*, which is given by the expression in parentheses, is relevant for weighting or quantity effects.

[14] In European Union (2020, Art. 3, 1(b)), the freedom of choice reads as follows: "The expenditure shares for year t-2 shall be reviewed and updated to make them representative for year t-1". In Eurostat (2018, Sections 3.5 and 8.2.3), price-updating and not price-updating are discussed as two specific options which are both generally compliant with this rule.

[15] In the French HICP, price-updating was applied as a general rule, while the possibility of adjusting to the previous year's expenditures was retained for exceptional cases where significant changes were identified.

excluded for all remaining euro area countries, Eq. (7) with $\iota = 1$ may not be regarded as an exact representation in the case of the euro area as a whole, although it is a very good approximation. According to Eurostat (2020), the HICP had to be compiled in 2021 using weights which really represent expenditure shares of the previous year, i.e. $\iota = 0$, in terms of a best-guess approach. Hence, in the countries under review, expenditure shares shifted from 2018 to 2020, implying that quantity effects reflect a two-year change in the quantities underlying the basket of goods. Following Eurostat (2021), statistical offices were obliged to derive the 2022 HICP weights once again according to the best-guess approach.

In Appendix A it is shown that replacing x_i in Eq. (3) with the weights $\widetilde{w}_i^{y-1}$ results in a decomposition of inflation rate $\pi^{y|m}$ into a pure price change component, $\mu^{y|m}$, and a quantity component, $\nu^{y|m}$:

$$\pi^{y|m} = \mu^{y|m} + \nu^{y|m} \ . \tag{8}$$

As decomposition (8) requires weights of the current and the previous year to be expressed by Eq. (7), it can be calculated from 2013 on.

- **Pure price change component:**

$$\mu^{y|m} = \begin{cases} \dfrac{\sum_{i=1}^{N} p_i^{y|m} \, q_i^{y-2-\iota}}{\sum_{i=1}^{N} p_i^{y-1|m} \, q_i^{y-2-\iota}} - 1 & \text{if } m = 1, \ldots, 11 \\[2ex] \pi^{y|12} & \text{if } m = 12 \end{cases} \tag{9}$$

  where $q_i^{y-2-\iota}$ denotes the quantity of product i consumed in year $y - 2 - \iota$. As a result, $\mu^{y|m}$ measures the aggregate price change between the current and previous year in month m, based on quantities of the year $y - 2 - \iota$. Conceptually, the pure price change component is thus measured by a Lowe index.

- **Quantity component:**

$$\nu^{y|m} = \gamma^{y|m} \cdot \sum_{i=1}^{N} \frac{p_i^{y|m}}{p_i^{y-1|12}} \left(w_i^{y-1} - \widetilde{w}_i^{y-1} \right) \tag{10}$$

  The difference between weights w_i^{y-1} and $\widetilde{w}_i^{y-1}$ lies in the use of quantities which are one year apart.[16] Hence, the quantity component measures the total impact of a change in quantities rather than weights.

In comparison, decomposition (4) can be calculated on the basis of publicly available

[16] In the period before 2012, a number of countries compiled the HICP as a fixed-basket index, i.e. they kept the basket of goods constant in all periods belonging to the same base year. This implies $w_i^{y-1} = \widetilde{w}_i^{y-1}$, hence, quantity effects are zero. The exception is when there is a base year changeover between $y - 1$ and $y - 2$. In this case (which usually occurred every five years), quantity effects reflect changes in the basket of goods from one base year to another.

information about prices and weights. It can be interpreted in a uniform manner for the HICP of the euro area and all euro area countries in the full period under analysis, because it allows us to disregard the conceptual and methodological heterogeneity of weight compilation practices across countries and over time. By contrast, decomposition (8) requires the introduction of an additional weighting scheme. Its compilation is less of a problem than the fact that case distinctions are needed in order to give the resulting quantity components a meaningful interpretation, in particular as regards comparability across countries and over time.

4 Empirical results

The decomposition into price change and weighting effects is calculated for the euro area and the euro area countries using publicly available HICP data for the period from January 1997 to December 2021. For each country and product, a series of up to 300 monthly price index numbers and (annual) weights is available. To ensure consistency across countries and over time, we sacrifice some granularity and use nearly the same selection of product categories (see Tab. B.1 in the appendix for an overview). The number of product categories considered varies between 68 for Malta and 76 for Germany and the euro area.

In the previous sections, we argued that weight compilation rules have evolved over time and practices have been subject to some country-specific discretion. Instead of drawing fully fledged pictures for the euro area and all euro area countries which would end up with an overflow of data and results, we will underpin the key findings with selective empirical evidence in an illustrative and meaningful manner.

The exposition of results is organised as follows. First, we draw attention to the headline results, which relate to the (absolute) size and time variation of the weighting effect in HICP inflation. We provide empirical evidence for the euro area HICP over its complete history. We complement this by an analysis of the German, French and Italian HICPs. These countries are chosen not only because they are the three largest ones (accounting for 65.7% of the euro area HICP in 2021). Their results also exemplify the diversity of country evidence. Second, we focus on the weighting effects in 2021 and the two years before in order to shed light on the effects of changing consumption patterns during the COVID-19 crisis. In this part, we flesh out the underlying arithmetics of the weighting effect. Third, we look at the difference between weighting and quantity effects for the euro area HICP and the HICPs of Germany, France and Italy in the reduced sample starting in January 2013.

Key findings on the weighting effect. On average, euro area inflation has been affected only marginally by changing weighting schemes since 1998. As displayed in Fig. 2,

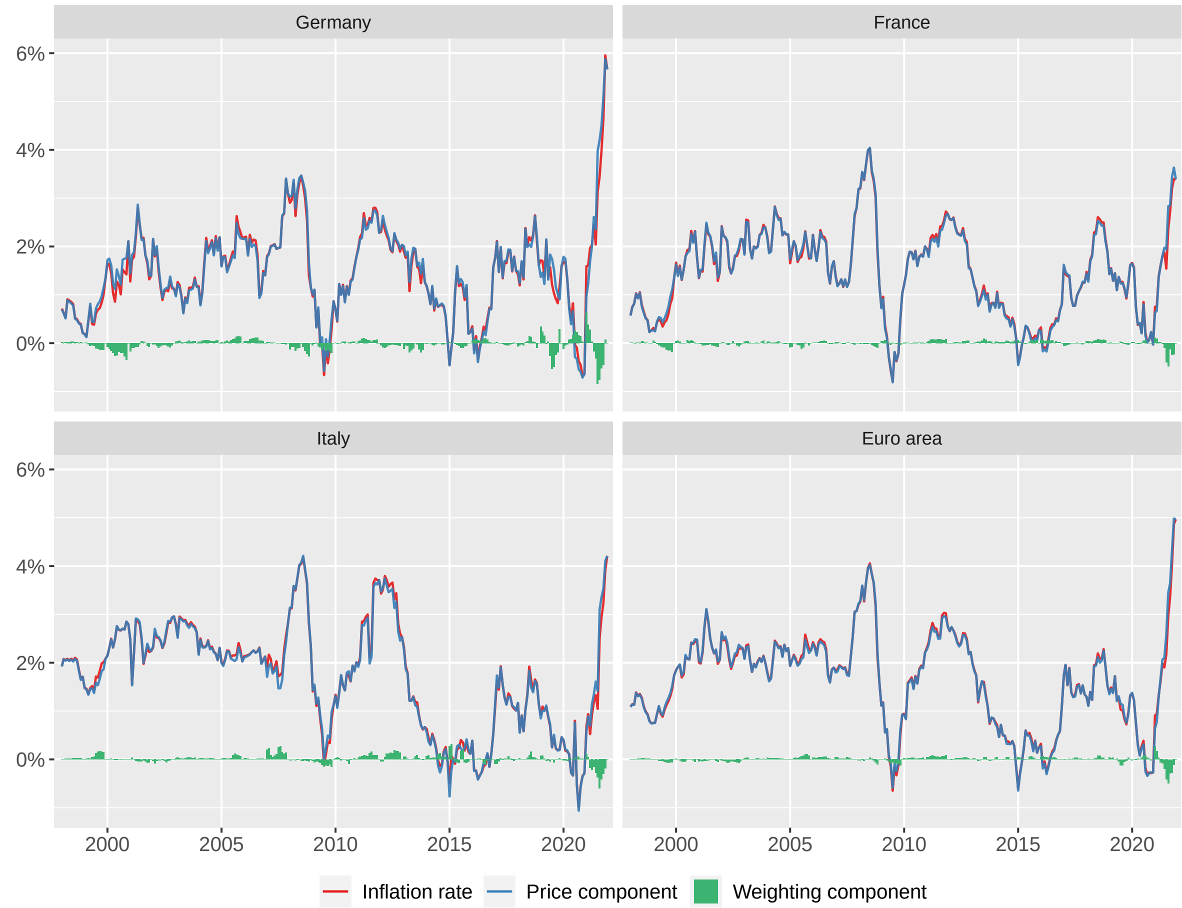


Figure 2: Decomposition of official HICP inflation rates into price change (in %) and weighting components (in pp).

the annual price change aggregated using constant weights closely follows the year-on-year percentage change of the euro area HICP. In some phases, however, weighting effects have been sizeable. For the euro area HICP, this is the year 2021, when HICP weights were adjusted due to changing consumption patterns on account of the COVID-19 crisis. In the HICPs of individual euro area countries, weighting effects of a recognisable (absolute) size have clustered in other periods, too. Fig. 3 reveals the years 2000 and 2019 in the German HICP, for instance.

The clustering may typically spread over complete calendar years. Recalling Eq. (6), this is due to the fact that HICP weights shift only with the turn of the calendar year and, once substantial, they have the potential to increase the weighting effects from January to November in absolute value. The sign of the weighting effect depends on the intra-annual fluctuations of individual products' price ratios in connection with the distribution of weight shifts across products (see the next paragraph for an illustration). As a consequence, weighting effects may oscillate between positive and negative territory within a calendar year under specific circumstances. The weighting effects in the German HICP since 2019 are a telling example of this phenomenon.

Weighting effects tend to average out over the long run. The full-sample means are virtually zero in the euro area HICP and the HICPs of all euro area countries for which

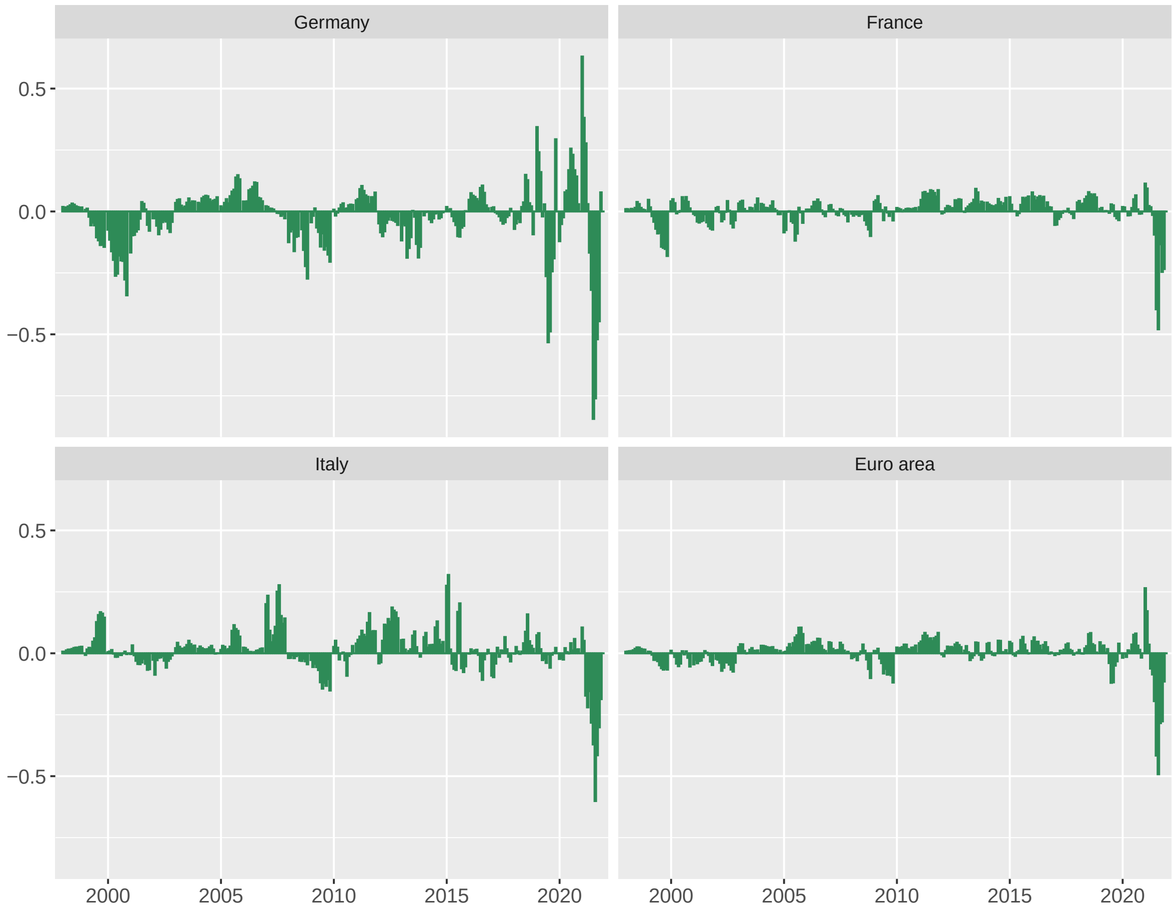


Figure 3: Weighting component (in pp) in euro area HICPs.

results are available from 1998 (see Tab. 1). There are notable differences regarding the volatility, however. The weighting effects in the euro area HICP have fluctuated in the small interval between −0.49 pp and 0.27 pp since 1998 (with a standard deviation of 0.06 pp). Amongst euro area countries with the full HICP history, this smallest standard deviation is also found in the French HICP. The weighting effects span an interval from −0.6 pp to 0.32 pp in the case of Italy and from −0.84 pp to 0.63 pp in the case of Germany. Compared to the spreads, cross-country differences are smaller in terms of standard deviations. In addition, the interquartile ranges only amount to 0.05 pp for weighting effects in the Italian HICP and 0.09 pp in the German HICP. Both pieces of evidence allow us to conclude that the distributional mass of the distribution is typically concentrated in a small interval around zero while extreme realisations occur very seldom.

In Tab. 1, we report summary statistics of the weighting effects for the HICPs of the euro area and all euro area countries. Most euro area countries share the feature that weighting effects have a zero mean and their distributions are strongly leptokurtotic. Greece and Luxembourg are among a few smaller countries (with a long HICP history) for which weighting effects vary rather sizeably. Cyprus and especially Malta (with results from 2010 onwards) are outliers, as weighting effects do not average out over the longer term and exhibit large or even huge volatility.

	Since	Range	IQR	Mean	SD	Skew.	Kurt.
Austria	1998	0.69	0.05	0.00	0.08	-0.35	6.91
Belgium	1998	1.45	0.08	0.02	0.17	2.42	12.94
Cyprus	2010	2.18	0.29	0.06	0.35	1.15	2.66
Germany	1998	1.47	0.09	-0.02	0.14	-1.45	10.34
Estonia	2013	0.74	0.08	-0.01	0.11	-1.94	7.75
Spain	1998	0.96	0.06	0.01	0.09	-0.46	8.95
Finland	1998	0.59	0.06	-0.00	0.08	-1.19	3.56
France	1998	0.59	0.04	0.00	0.06	-3.56	21.88
Greece	2003	2.46	0.12	0.03	0.26	-0.56	8.45
Ireland	1998	1.39	0.12	0.03	0.17	-1.00	3.59
Italy	1998	0.92	0.05	0.01	0.09	-1.47	10.57
Lithuania	2017	0.96	0.15	0.03	0.18	0.88	1.09
Luxembourg	1998	2.89	0.09	-0.02	0.29	0.68	8.71
Latvia	2016	0.42	0.05	0.01	0.06	-1.16	5.77
Malta	2010	7.93	0.12	-0.16	1.03	-3.09	12.47
Netherlands	1998	1.55	0.05	-0.01	0.16	-3.98	23.23
Portugal	1998	1.11	0.08	0.02	0.13	-2.39	9.61
Slovenia	2009	1.44	0.10	-0.05	0.21	-2.97	11.28
Slovakia	2011	0.89	0.11	-0.00	0.13	0.06	2.70
Euro area	1998	0.76	0.04	0.00	0.06	-3.23	22.55

Table 1: Summary statistics of weighting component (in pp) in euro area HICPs.

Policymakers may take note of the weighting effects if their absolute values exceed a perception threshold. To further investigate the likelihood of increased policy attention, we classify the monthly effects into three categories. Within the interval of ±0.1 pp around zero, weighting effects are supposed to be widely disregarded. With an absolute magnitude of above 0.1 pp and below 0.3 pp, they may not be fully negligible. Even so, they are not large enough to be construed as an element with a severe impact on inflation rates. As reported in Tab. 2, weighting effects have been within the interval of ±0.1 pp around zero in 95% of the monthly observations for the euro area HICP since 1998. Moreover, there was no effect above 0.3 pp in absolute value until mid-2021. While weighting effects were as irrelevant in the French HICP before summer 2021, the perception threshold has not been surpassed in three-quarters of the monthly observations in the German HICP and five-sixths in the Italian HICP. Looking at the complete HICP history, weighting effects of at least 0.3 pp have been a very rare event in the German and the Italian HICPs, too.

As regards the HICPs for Belgium, Greece and Luxembourg, at least three-fifths of the monthly weighting effects are located in the ±0.1 pp interval. Among them, for Greece and Luxembourg a comparatively large number of effects surpassed 0.3 pp in absolute value. Belgium has experienced weighting effects of medium (absolute) size. This is also observed for Ireland, where only 57% of monthly weighting effects fall in the ±0.1 pp interval.

Weighting effects in the COVID-19 crisis. Inflation was recognisably affected by weighting effects in 2021. This is evidenced for the euro area HICP and, among the large euro area countries, sizeable weighting effects are found not only in the German HICP

	MAD	Relative frequency		
		[0,0.1]	(0.1,0.3]	(0.3,Inf]
Austria	0.05	89.9	8.7	1.4
Belgium	0.10	70.8	24.0	5.2
Cyprus	0.25	33.3	38.9	27.8
Germany	0.08	75.0	21.2	3.8
Estonia	0.07	76.9	21.3	1.9
Spain	0.05	85.4	12.8	1.7
Finland	0.05	84.7	14.2	1.0
France	0.03	95.8	3.5	0.7
Greece	0.14	63.2	23.2	13.6
Ireland	0.11	56.9	34.4	8.7
Italy	0.05	83.3	14.9	1.7
Lithuania	0.14	61.7	23.3	15.0
Luxembourg	0.15	68.4	16.7	14.9
Latvia	0.04	90.3	9.7	-
Malta	0.52	55.6	25.0	19.4
Netherlands	0.07	83.7	11.5	4.9
Portugal	0.08	71.5	24.7	3.8
Slovenia	0.13	72.4	18.6	9.0
Slovakia	0.09	69.7	26.5	3.8
Euro area	0.04	95.1	4.2	0.7

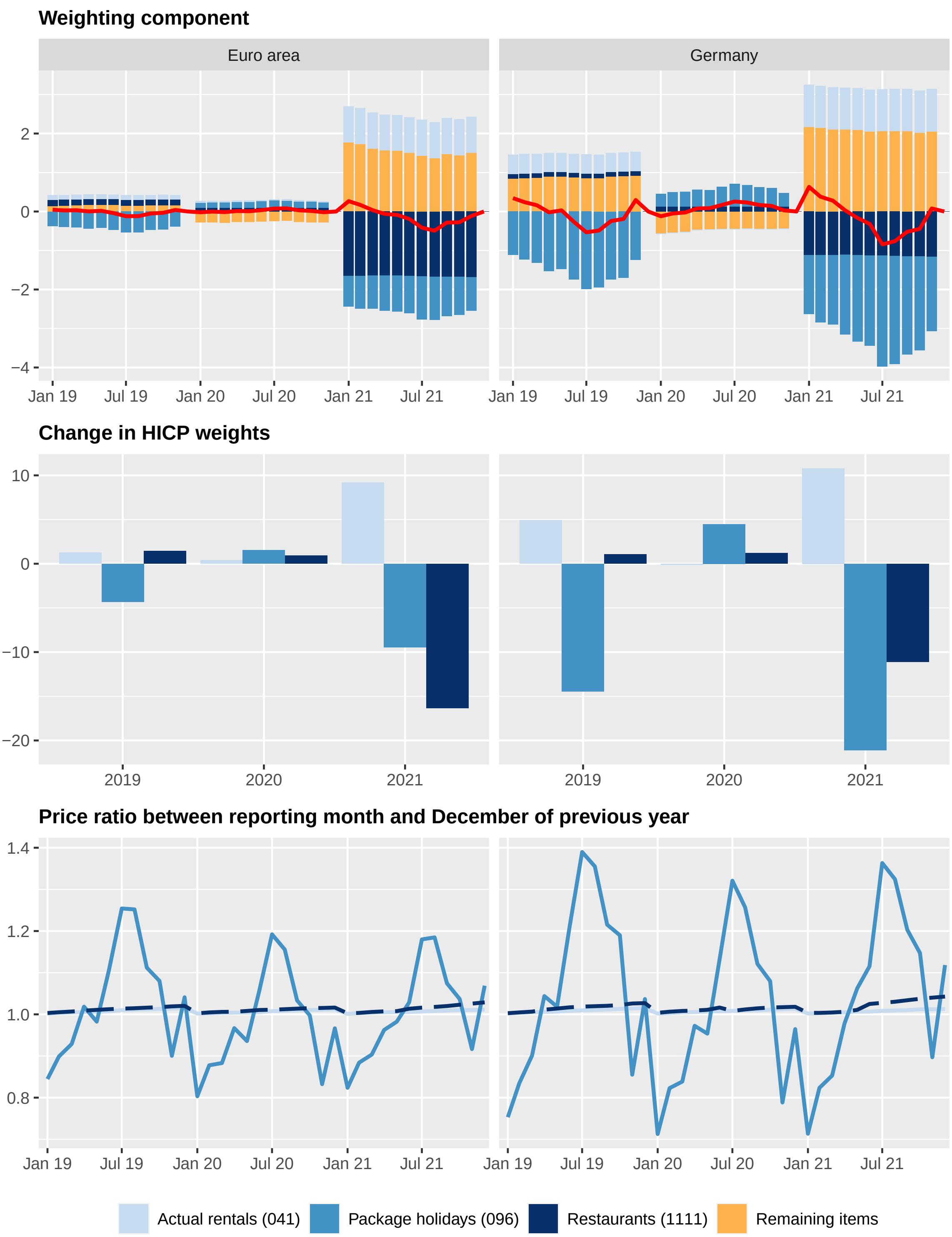
Table 2: Mean absolute deviation (MAD) of weighting components and relative frequencies (in %) of absolute weighting components.

but also in the French and Italian HICPs, which were comparatively insensitive to this impact before (see Fig. 4 and 5). In July and August 2021, the weighting effect clearly surpassed the perception threshold. In one of these months, it even reached a historical minimum. Moreover, looking at the euro area, German and French HICPs, the year 2021 started with weighting effects charting a historical maximum which, in the case of France only, may be regarded as negligible in size. Hence, what matters is not only the (absolute) magnitude of the weighting effect but also its variation over the calendar year.

A look at the contributions of some selected product categories makes it possible to better understand the arithmetic of the weighting effect. In the COVID-19 crisis, households spent less in restaurants and on hotels and travel, leading to a considerable decline in the 2021 HICP weights for the product categories "Restaurants, cafés and the like", "Passenger transport by air", "Accommodation services", "Package holidays" and "Fuels and lubricants". By contrast, the weight of "Actual rentals for housing" increased greatly.[17] As a consequence, the former product categories make negative contributions to the weighting effect whereas the latter has a positive impact over the whole year.

The price ratio between the reporting month and December of the previous year shapes the magnitude of the intra-annual contributions in terms of absolute value. The importance of the interplay between weight change and intra-annual price variation is illustrated in Fig. 4 for the euro area and Germany as well as in Fig. 5 for France and

[17] The strong increase of the 2021 HICP weight of actual rentals for housing is explained by a denominator effect. While the total budgets of many households decreased markedly in the COVID-19 crisis, their rental expenses did not react given that rents tend to exhibit downward rigidity.



Note: The weighting component (in pp, red line) sums up the contributions of all price items three of which are shown explicitly as stacked bars together with the aggregate contributions of the remaining items.

Figure 4: Weighting component (in pp), change in HICP weights (in per mille points) and December price ratios in euro area and German HICPs between 2019 and 2021.

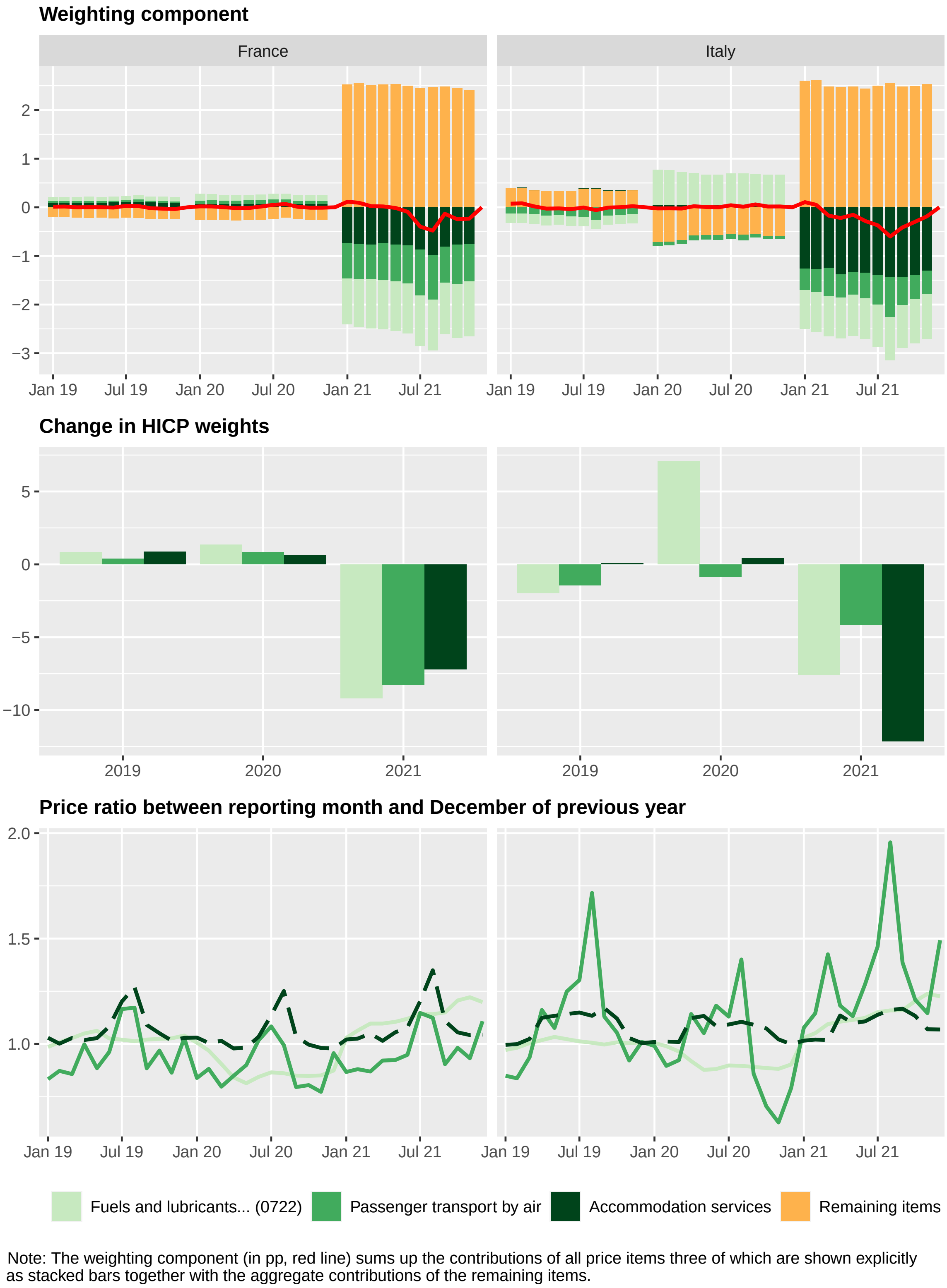


Figure 5: Weighting component (in pp), change in HICP weights (in per mille points) and December price ratios in French and Italian HICPs between 2019 and 2021.

Italy. We focus on the contributions of selected product categories to the weighting effect. The selections differ in the two figures. In the euro area and German HICPs, package holiday prices exhibit a very pronounced seasonal pattern. As shown in the top panels of Fig. 4, the contribution of this product category to the weighting effect in 2021 differs from smallest (in January) to largest (in August) by 0.34 pp in the case of the euro area HICP and 1.34 pp in the case of the German HICP (where the largest contribution is in July and the smallest is in January, too).[18] This contribution results on the one hand from a change in weights by −9.43 per mill points for the euro area and −21.12 per mill points for Germany in 2021, which can be seen in the middle panels. The change in weights is constant within the calendar year while December price ratios – depicted in the bottom panels – vary from month to month. For Germany, these price ratios lie below 1 between January and April 2021. Consequently, according to Eq. (6), the strong change in package holiday weights in 2021 is dampened in these months. From May to October, the arithmetic behaves in the opposite way. As price ratios are greater than 1, the individual contribution of the change in weights is amplified.

In the French and Italian HICPs, the decline in expenses for flight tickets and accommodation during the COVID-19 crisis plays a major role. Considerable negative weighting effects appear in July and August 2021, as these products exhibit seasonal price peaks in the summer months. "Fuels and lubricants" in France and Italy serve as an example that not only products with pronounced seasonal price variation have the potential to make a significant contribution. This product category contributed negatively to the weighting effect throughout the entire year because the decline in expenses in 2020 is amplified by particularly high price ratios. The contributions differ from smallest (in January) to largest (in November) by 0.17 pp in the case of the French HICP and 0.15 pp in the case of the Italian HICP.

Differences between weighting and quantity effects. Quantity effects are calculated according to Eq. (10) from 2013 onwards for the euro area as well as for Germany, France and Italy. Fig. 6 shows that quantity effects are very similar to weighting effects in the German HICP, while this is not so much the case in the French and Italian HICPs. Not least because of the variation across the largest countries, the evidence for the euro area HICP appears to lie somewhere in between. In particular, the (contemporaneous) correlation between weighting and quantity effects is highest in Germany (0.96), followed by Italy (0.90), the euro area (0.88) and France (0.83). The relatively strong empirical association in the case of Germany is underlined by the fact that in 93% of the monthly observations, quantity and weighting effects have the same sign. The relative frequency is markedly smaller in the HICPs for Italy (82%), the euro area (79%) and France (72%).

[18] We observe the same patterns in 2019 when the HICP weight of package holidays also decreased substantially, particularly in Germany, and with opposite signs and less accentuated in 2020 when its weight partially recovered.

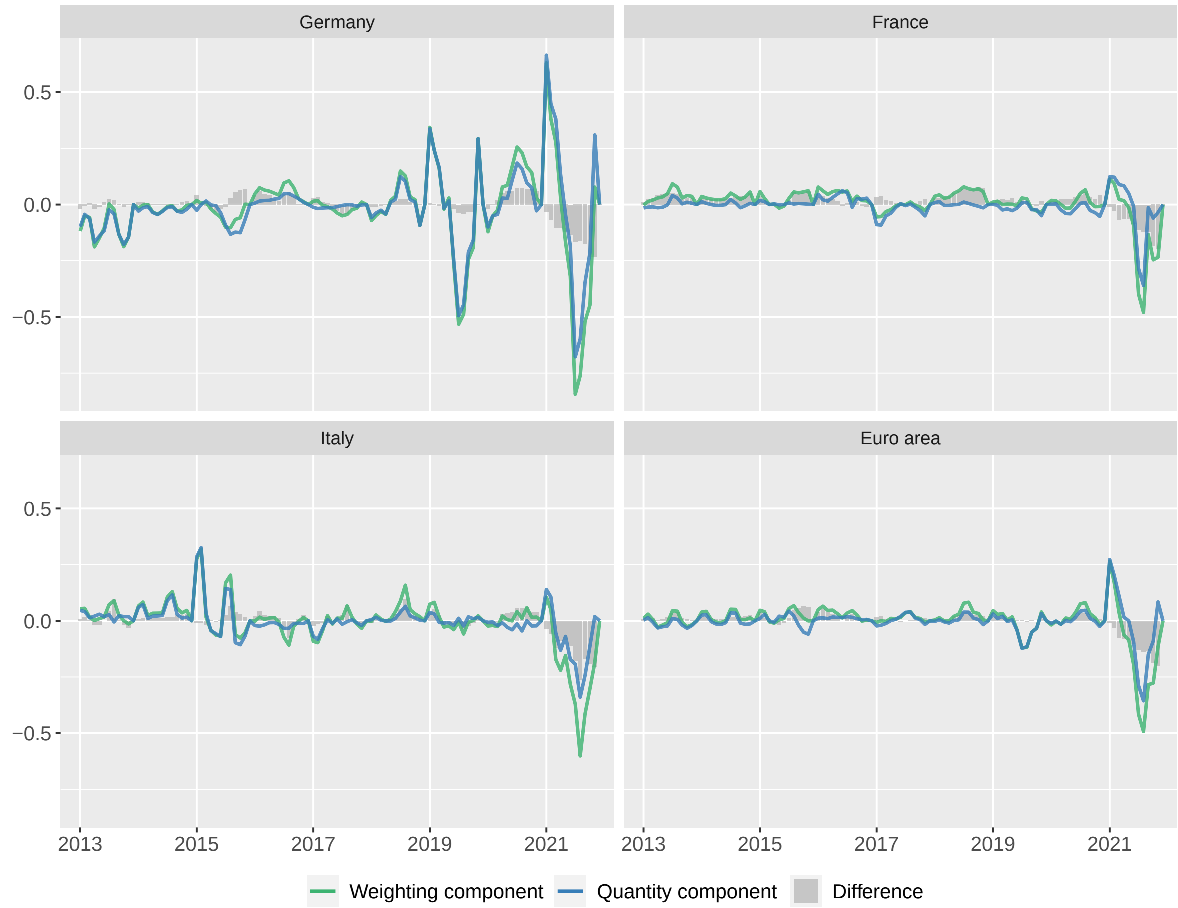


Figure 6: Weighting and quantity components (in pp) in euro area HICPs.

Quantity effects tend to be of a smaller size than weighting effects. In the sample under review, the mean absolute quantity effect in the euro area HICP is nearly three-quarters the size of the mean absolute weighting effect. In the case of Germany, the mean absolute quantity effect is one-eighth smaller than the mean absolute weighting effect, while it is one-third in the case of Italy and two-fifths in the case of France.

In contrast to the evidence over the longer term, quantity effects strongly mimic weighting effects during the COVID-19 crisis. The intra-annual pattern is virtually identical for the euro area HICP and the three country-specific HICPs under review. The 2021 minimum values of the quantity effect are of a smaller (absolute) size than those observed for the weighting effect. In August 2021, when the weighting effect reached -0.49 pp in the euro area HICP, the quantity effect was -0.36 pp. The proportion of quantity to weighting effects in August 2021 turns out to be rather similar in the case of the German and French HICPs, whereas the quantity effect was about half the weighting effect in the Italian HICP.

The similarity of weighting and quantity effects over the course of 2021 suggests that changes in real consumption have overwhelmingly driven the shifts in nominal expenditures during the COVID-19 crisis, whereas the impact of relative price changes on the variation of expenditures across product categories has been small.

5 Concluding remarks

As the HICP is constructed as a Laspeyres-type index with weights changing at the beginning of every calendar year, inflation (measured as the annual percentage change of this index) does not reflect pure price developments. The experience of the COVID-19 crisis debunked the view that inflation measurement tends to be insensitive to changes in weights. Reaching an absolute size of 0.5 pp in summer 2021, the weighting effect in euro area inflation clearly surpassed the perception threshold for policymakers. The year 2021 saw historical extreme values for the weighting effect in euro area countries, too.

The removal of the weighting effect from HICP inflation rates does not yield year-on-year percentage changes which reflect pure price changes aggregated over the basket of goods and services representing the HICP. This is done by removing quantity effects from HICP inflation. While the quantity effect may be lauded as having a sound footing in index number theory, the weighting effect is advantageous because it can be measured simply by relying on publicly available HICP data (price index numbers and weights) and avoiding case distinctions over time and across countries, as is required for quantity effects to be properly interpretable. Our empirical investigation shows that the (absolute) differences between two types of effect tend to be small in phases when weight changes are sizeable. In the year 2021, for instance, weighting and quantity effects are very similar, suggesting that changes in real consumption have overwhelmingly driven the shifts in nominal expenditures during the COVID-19 crisis.

With its tremendous effects on private consumption, the COVID-19 crisis has been a stress test for the compilation and interpretation of the HICP as well as any (COGI-type) CPI. While it may not be generally advisable to call well established measurement rules and practices into question solely as a result of a "once-in-a-lifetime" event, the appearance of sizeable weighting effects all over the euro area should prompt European statisticians to consider making inflation measurement more robust and/or increasing transparency with regard to the representativeness of expenditure patterns in the periods compared in inflation measures.

We begin our reflections with the basic premise that an annual updating of weights is advantageous in order to ensure the up-to-date representativity of the HICP, while index values of the respective previous year(s) should not be revised (i.e. newly introduced expenditure patterns are not applied to back data). In this framework, we have to accept chain-linking but would generally be free to select from a set of various techniques. Chaining over December of the previous year, as prescribed in the HICP Framework Regulation (European Union, 2016, Art. 2 (16)), makes it impossible to avoid weight changes influencing year-on-year percentage changes. The question is merely whether or not weighting effects matter quantitatively, as they sometimes exceed the perception threshold of policymakers. By contrast, the over-the-year approach (i.e. linking with the respective month in the previous year) produces unaffected year-on-year percentage changes. Eiglsperger and Schackis (2009, p. 5) argue that this would come "at the high cost of severely affecting the short-term properties of an HICP series". This statement makes clear that the choice of chain-linking technique is actually a trade-off decision. It might be an area for future academic work to reassess the pros and cons of each approach, taking into account the experience up until recently with the COVID-19 crisis.

With annual updating of weights and chaining over December being kept as HICP measurement principles, price statisticians may envisage a further harmonisation in weight updating procedures. Namely, the guidance developed to deal with the challenges of the COVID-19 crisis and applied to derive 2021 and 2022 HICP weights (Eurostat, 2020, 2021) might become established as a general standard. This would stipulate best-guess estimates for the weight reference period, implying that both weighting and quantity effects would – at least in conceptual terms – be precisely measurable for the euro area HICP and the HICPs of all euro area countries. It might also be worth considering whether the impact of weight shifts on inflation should be communicated regularly or occasionally. A potential rule could be that weighting and quantity effects are published as an additional piece of information if their absolute values exceed a certain threshold. Users could find this information helpful, as it is commonly measurable and interpretable in terms of reflecting aggregate price developments at constant (previous-year) weights.

A Mathematical derivations

The HICP of the current year is calculated based on weights representing private households' consumption expenditures of the previous calendar year. The weights are updated from year to year. In the event of shifts in the consumption structure, the HICP annual change rates thus do not accurately reflect the pure price change. In the following, we derive two decompositions of HICP inflation which disentangle either price and weight changes or pure price and quantity changes.

General decomposition of HICP inflation. The HICP is calculated as a Laspeyres-type index and chained over December. Its index value in month m ($m = 1, \ldots, 12$) of year y can be written as

$$P^{y|m} = \sum_{i=1}^{N} \frac{p_i^{y|m}}{p_i^{y-1|12}} \, w_i^{y-1} \cdot \prod_{l=0}^{y-y^0} \delta^{y-l} \tag{A.1}$$

where N is the number of products ($i = 1, \ldots, N$) in the consumption basket and y^0 the starting point of the index time series (e.g. the year when HICP compilation started).[19] The first term on the right-hand side of Eq. (A.1) is a weighted sum of December price

[19] Calculating the actual index value would require multiplying $P^{y|m}$ in Eq. (A.1) by 100 and normalising this result to a specific base year. As we are looking at annual change rates, however, both the factor of 100 and the factor of normalisation cancel out, and thus have no impact for the following derivations.

relatives, which is multiplied by a cumulative product of chaining factors, δ^{y-l}:

$$\delta^{y-l} = \begin{cases} 1 & \text{if } y-l = y^0 \\ \sum_{i=1}^{N} \frac{p_i^{y-l-1|12}}{p_i^{y-l-2|12}} \, w_i^{y-l-2} & \text{if } y-l > y^0 \,. \end{cases}$$

The chaining factor δ^{y-l} is constant within a calendar year. For the starting point of the time series, no chaining is required. Hence, $\delta^{y^0} = 1$.

Inserting Eq. (A.1) in Eq. (2), the definition of the inflation rate, yields

$$\pi^{y|m} = \delta^y \cdot \frac{\sum_{i=1}^{N} \frac{p_i^{y|m}}{p_i^{y-1|12}} \, w_i^{y-1}}{\sum_{i=1}^{N} \frac{p_i^{y-1|m}}{p_i^{y-2|12}} \, w_i^{y-2}} - 1 \,. \tag{A.2}$$

Eq. (A.2) shows that the cumulative product of chaining factors reduces to the latest available chaining factor, δ^y. Looking at inflation rates as a percentage change of a price index over one year requires at least two index values. Hence, $y > y^0$, and consequently

$$\delta^y = \sum_{i=1}^{N} \frac{p_i^{y-1|12}}{p_i^{y-2|12}} \, w_i^{y-2} \,.$$

Moreover, Eq. (A.2) shows that the price ratios, $p_i^{y|m}/p_i^{y-1|12}$ and $p_i^{y-1|m}/p_i^{y-2|12}$, rely on two different sets of weights, w_i^{y-1} and w_i^{y-2}, causing weighting effects in the inflation rate. This is at least true for months $m = 1, \ldots, 11$. December ($m = 12$), however, is a special case as Eq. (A.2) simplifies to

$$\pi^{y|12} = \sum_{i=1}^{N} \frac{p_i^{y|12}}{p_i^{y-1|12}} \, w_i^{y-1} - 1 \tag{A.3}$$

when inserting the definition of δ^y. Eq. (A.3) shows that $\pi^{y|12}$ is defined by a weighted sum of price relatives between the current and previous year, relying solely on the weights w_i^{y-1}. Consequently, weighting effects are not present in December months. A decomposition of the inflation rate is thus only meaningful in months $m = 1, \ldots, 11$. To this end, Eq. (A.2) can be split into

$$\pi^{y|m} = \gamma^{y|m} \cdot \left(\sum_{i=1}^{N} \frac{p_i^{y|m}}{p_i^{y-1|12}} \, \left(w_i^{y-1} - x_i\right) + \sum_{i=1}^{N} \frac{p_i^{y|m}}{p_i^{y-1|12}} \, x_i \right) - 1 \tag{A.4}$$

for months $m = 1, \ldots, 11$, where x_i is for now simply a place holder, and

$$\gamma^{y|m} = \delta^y \left(\sum_{i=1}^{N} \frac{p_i^{y-1|m}}{p_i^{y-2|12}} \, w_i^{y-2} \right)^{-1} = P^{y-1|12} / P^{y-1|m} \tag{A.5}$$

is a scaling factor, which is equivalent to the ratio of HICP index values of December and month m in year $y-1$.

Price change and weighting components in HICP inflation. Eq. (A.2) shows that inflation rate $\pi^{y|m}$ depends on the HICP weights w_i^{y-1} and w_i^{y-2}, which is why weighting effects can be derived between these two sets of official HICP weights. Replacing x_i with w_i^{y-2} in Eq. (A.4) yields

$$\begin{aligned}\pi^{y|m} &= \underbrace{\gamma^{y|m} \cdot \sum_{i=1}^{N} \frac{p_i^{y|m}}{p_i^{y-1|12}} \left(w_i^{y-1} - w_i^{y-2}\right)}_{=\kappa^{y|m}} + \underbrace{\gamma^{y|m} \cdot \sum_{i=1}^{N} \frac{p_i^{y|m}}{p_i^{y-1|12}}\, w_i^{y-2} - 1}_{=\lambda^{y|m}} \\ &= \kappa^{y|m} + \lambda^{y|m}\,,\end{aligned}$$

for months $m = 1, \ldots, 11$. For all months, we arrive at the weighting component

$$\kappa^{y|m} = \begin{cases} \gamma^{y|m} \cdot \sum_{i=1}^{N} \frac{p_i^{y|m}}{p_i^{y-1|12}} \left(w_i^{y-1} - w_i^{y-2}\right) & \text{if } m = 1, \ldots, 11 \\ 0 & \text{if } m = 12 \end{cases}$$

and the price change component

$$\lambda^{y|m} = \begin{cases} \gamma^{y|m} \cdot \sum_{i=1}^{N} \frac{p_i^{y|m}}{p_i^{y-1|12}}\, w_i^{y-2} - 1 & \text{if } m = 1, \ldots, 11 \\ \pi^{y|12} \text{ in Eq. (A.3)} & \text{if } m = 12\,. \end{cases}$$

For $m = 12$, the price change component is not affected by any weighting effects. Hence, $\lambda^{y|m}$ is defined by Eq. (A.3) while the weighting component, $\kappa^{y|12}$, is 0 in this month. For months $m = 1, \ldots, 11$, $\kappa^{y|m}$ measures the impact on the inflation rate resulting from a change in weights w_i^{y-1} and w_i^{y-2}.

Pure price change and quantity components in HICP inflation. Similarly, replacing x_i with the weights $\widetilde{w}_i^{y-1}$ in Eq. (A.4) gives the decomposition of the inflation rate $\pi^{y|m}$ into a quantity component, $\nu^{y|m}$, and a pure price change component, $\mu^{y|m}$:

$$\begin{aligned}\pi^{y|m} &= \underbrace{\gamma^{y|m} \cdot \sum_{i=1}^{N} \frac{p_i^{y|m}}{p_i^{y-1|12}} \left(w_i^{y-1} - \widetilde{w}_i^{y-1}\right)}_{=\nu^{y|m}} + \underbrace{\gamma^{y|m} \cdot \sum_{i=1}^{N} \frac{p_i^{y|m}}{p_i^{y-1|12}}\, \widetilde{w}_i^{y-1} - 1}_{=\mu^{y|m}} \\ &= \nu^{y|m} + \mu^{y|m}\,.\end{aligned} \tag{A.6}$$

for months $m = 1, \ldots, 11$. As shown in the following, the weights $\widetilde{w}_i^{y-1}$ deviate from the official HICP weights w_i^{y-1} in the use of quantities dating back one year further.

In measurement practice, HICP weights were derived using the quantities of year $y-2$

between 2012 and 2020 while quantities of $y-1$ were applied in 2021. Hence, the following case distinction in the definition of weights is necessary due to the change in the derivation of HICP weights in 2021 caused by the COVID-19 pandemic:

$$\iota = \begin{cases} 1 & \text{if } 2012 \leq y \leq 2020 \\ 0 & \text{if } y = 2021\,. \end{cases}$$

If price-updated, official HICP weights w_i^{y-1} and w_i^{y-2} can be expressed by

$$w_i^{y-1} = \frac{p_i^{y-1|12}\; q_i^{y-1-\iota}}{\sum_{j=1}^{N} p_j^{y-1|12}\; q_j^{y-1-\iota}} \qquad \text{and} \qquad w_i^{y-2} = \frac{p_i^{y-2|12}\; q_i^{y-2-\iota}}{\sum_{j=1}^{N} p_j^{y-2|12}\; q_j^{y-2-\iota}} \tag{A.7}$$

while the weights $\widetilde{w}_i^{y-1}$ are derived from quantities $q_i^{y-2-\iota}$ consumed in year $y-2-\iota$ and price-updated from this year to December of year $y-1$.[20] Technically, $\widetilde{w}_i^{y-1}$ can be derived from official HICP weights w_i^{y-2} in Eq. (A.7), and thus be written as

$$\widetilde{w}_i^{y-1} = \frac{\frac{p_i^{y-1|12}}{p_i^{y-2|12}}\; w_i^{y-2}}{\sum_{j=1}^{N} \frac{p_j^{y-1|12}}{p_j^{y-2|12}}\; w_j^{y-2}} = \frac{p_i^{y-1|12}\; q_i^{y-2-\iota}}{\sum_{j=1}^{N} p_j^{y-1|12}\; q_j^{y-2-\iota}}\,. \tag{A.8}$$

Hence, $\widetilde{w}_i^{y-1}$ deviates from the official HICP weights w_i^{y-1} solely in the use of quantities dating back one year further.

Using definitions (A.5), (A.7) and (A.8), the pure price change component, $\mu^{y|m}$, in Eq. (A.6) can be written as:

$$\mu^{y|m} = \begin{cases} \dfrac{\sum_{i=1}^{N} p_i^{y|m}\; q_i^{y-2-\iota}}{\sum_{i=1}^{N} p_i^{y-1|m}\; q_i^{y-2-\iota}} - 1 & \text{if } m = 1, \ldots, 11 \\ \pi^{y|12} \text{ in Eq. (A.3)} & \text{if } m = 12 \end{cases}$$

while the quantity component $\nu^{y|m}$ is defined as the difference between official inflation and the pure price change component: $\nu^{y|m} = \pi^{y|m} - \mu^{y|m}$.

B COICOP products by country

The following table provides a country overview of the selected products used in the calculation of decompositions (6) and (10).

[20] Note that only the price update from the previous year's average to December is obligatory while the price update from $y-2-\iota$ to $y-1$ is voluntary. Hence, we consider here the price-updating option; see also Fn. 14.

COICOP	ID	AT	BE	CY	DE	EE	ES	FI	FR	GR	IE	IT	LT	LU	LV	MT	NL	PT	SI	SK	U2
Bread and cereals	0111	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Meat	0112	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Fish	0113	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Milk, cheese and eggs	0114	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Oils and fats	0115	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Fruit	0116	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Vegetables	0117	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sugar, jam, honey, chocolate...	0118	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Food products n.e.c.	0119	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Coffee, tea and cocoa	0121	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mineral waters, soft drinks, fruit...	0122	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Spirits	0211	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Wine	0212	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Beer	0213	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Tobacco	022	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Clothing materials	0311	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Garments	0312	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Other articles of clothing...	0313	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Cleaning, repair and hire of...	0314	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Footwear	032	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Actual rentals for housing	041	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Materials for the maintenance...	0431	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Services for the maintenance...	0432	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Water supply and misc. services...	044	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Electricity	0451	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Gas	0452	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Liquid fuels	0453	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	×	×	✓	✓	×	✓
Solid fuels	0454	✓	✓	✓	✓	✓	×	✓	✓	✓	✓	✓	✓	✓	✓	×	×	✓	✓	✓	✓

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COICOP	ID	AT	BE	CY	DE	EE	ES	FI	FR	GR	IE	IT	LT	LU	LV	MT	NL	PT	SI	SK	U2
Heat energy	0455	✓	×	×	✓	✓	×	✓	✓	×	×	×	✓	✓	✓	×	✓	×	✓	✓	✓
Furniture and furnishings	0511	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Carpets and other floor coverings	0512	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Repair of furniture, furnishings...	0513	×	×	✓	✓	×	✓	✓	✓	×	×	✓	✓	×	×	×	✓	✓	×	×	✓
Household textiles	052	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Household appliances	053	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Glassware, tableware and household...	054	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Tools and equipment for house...	055	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Non-durable household goods	0561	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Domestic services and household...	0562	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Health	06	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Purchase of vehicles	071	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Spare parts and accessories for...	0721	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Fuels and lubricants for personal...	0722	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Maintenance and repair of personal...	0723	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Other services in respect of...	0724	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Passenger transport by railway	0731	✓	✓	×	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	✓	✓	✓	✓	✓
Passenger transport by road	0732	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Passenger transport by air	0733	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Passenger transport by sea...	0734	×	×	×	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	×	✓
Combined passenger transport	0735	✓	✓	×	✓	✓	✓	✓	✓	✓	✓	✓	×	✓	×	×	✓	✓	✓	✓	✓
Other purchased transport services	0736	✓	✓	✓	✓	×	✓	✓	✓	✓	✓	✓	✓	✓	×	×	✓	✓	✓	✓	✓
Communication	08	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Equip. for reception, recording...	0911	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Photographic and cinematographic...	0912	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Information processing equipment	0913	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Recording media	0914	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Repair of audio-visual...	0915	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

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COICOP	ID	AT	BE	CY	DE	EE	ES	FI	FR	GR	IE	IT	LT	LU	LV	MT	NL	PT	SI	SK	U2
Other major durables for recreation...	092	✓	✓	✓	✓	×	✓	✓	✓	✓	✓	✓	✓	✓	×	✓	✓	✓	✓	✓	✓
Other recreational items...	093	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Recreational and sporting services	0941	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Cultural services	0942	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Newspapers, books and stationery	095	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Package holidays	096	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Education	10	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Restaurants, cafes and the like	1111	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Canteens	1112	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Accommodation services	112	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Personal care	121	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Jewellery, clocks and watches	1231	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Other personal effects	1232	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Social protection	124	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Insurance connected with the...	1252	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Insurance connected with health	1253	✓	✓	✓	✓	×	✓	✓	✓	✓	✓	✓	✓	✓	×	✓	✓	✓	✓	✓	✓
Insurance connected with transport	1254	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Other insurance	1255	✓	✓	×	✓	✓	✓	×	×	×	✓	×	×	✓	×	×	✓	✓	×	×	✓
Financial services n.e.c.	126	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Other services n.e.c.	127	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Total	0000	74	73	71	76	72	74	75	75	73	74	74	74	75	69	68	74	75	73	72	76

Table B.1: COICOP positions used for calculations.

References

Astin, J. A. and Sellwood, D. J. (1997). Harmonization in the European Union: A Review of some Technical Issues. *3rd Ottawa Group Meeting*.

Balk, B. M. (2018). Mixed-form indices: a study of their properties. In *EURONA*, 1/2018, Eurostat, pp. 67–78.

Cavallo, A. (2020). *Inflation with Covid Consumption Baskets*. Working Paper 27352, National Bureau of Economic Research.

de Haan, J. and Akem, A. (2017). Calculating contributions of product categories to percentage changes in the annually chained Australian CPI. hiips://www.business.unsw.edu.au/research-site/centreforappliedeconomicresearch-site/newsandevents-site/workshops-site/Documents/paper-de-haan-contributions-to-change-14-november-2017.pdf, accessed: 18 March 2022.

Deutsche Bundesbank (2019). Dampening special effect in the HICP in July 2019. In *Monthly report*, 8/2019, Deutsche Bundesbank, pp. 57–59.

Deutsche Bundesbank (2021). One-off effects relating to COVID-19 in the HICP in 2021. In *Monthly report*, 2/2021, Deutsche Bundesbank, pp. 63–66.

Diewert, W. E. (2021). Basic index number theory. Draft chapter of *Consumer Price Index Theory*. hiips://www.imf.org/en/Data/Statistics/cpi-manual, accessed: 18 March 2022.

— and Fox, K. J. (2022). Measuring real consumption and consumer price index bias under lockdown conditions. *Canadian Journal of Economics/Revue canadienne d'économique*, forthcoming.

Divisia, F. (1926). L'Indice Monétaire et la Théorie de la Monnaie (Suite et fin). *Revue d'économie politique*, **40** (1), 49–81.

Eiglsperger, M. and Schackis, D. (2009). Weights in the harmonised index of consumer prices: Selected aspects from a user's perspective. *11th Ottawa Group Meeting*.

European Central Bank (2000). Extended and further harmonised coverage of the HICP. In *Monthly Bulletin*, March 2000, ECB, p. 23.

European Central Bank (2012). New standards for HICP weights. In *Monthly Bulletin*, April 2012, ECB, pp. 36–39.

European Central Bank (2021). Approximation of the effect of the weight change on the HICP rate. In *Inflation measurement and its assessment in the ECB's monetary policy strategy review*, Occasional Paper Series 265, ECB, pp. 27–28.

European Commission (1997). Commission Regulation (EC) No 2454/97 of 10 December 1997. *Official Journal of the European Communities*.

European Union (2016). Regulation (EU) 2016/792 of the European Parliament and of the Council of 11 May 2016. *Official Journal of the European Union*, **59**, 11–38.

European Union (2020). Commission Implementing Regulation (EU) 2020/1148 of 31 July 2020. *Official Journal of the European Union*, **63**, 12–23.

Eurostat (2018). *Harmonised Index of Consumer Prices (HICP): Methodological Manual*. Luxembourg: European Union.

— (2020). Guidance on the compilation of HICP weights in case of large changes in consumer expenditures. hiips://ec.europa.eu/eurostat/documents/10186/10693286/Guidance-on-the-compilation-of-HICP-weights-in-case-of-large-changes-in-consumer-expenditures.pdf, accessed: 1 December 2021.

— (2021). Derivation of HICP weights for 2022. hiips://ec.europa.eu/eurostat/documents/10186/10693286/Derivation-of-HICP-weights-for-2022.pdf, accessed: 1 December 2021.

Forsyth, F. G. (1978). The Practical Construction of a Chain Price Index Number. *Journal of the Royal Statistical Society. Series A (General)*, **141** (3), 348–358.

— and Fowler, R. F. (1981). The Theory and Practice of Chain Price Index Numbers. *Journal of the Royal Statistical Society. Series A (General)*, **144** (2), 224–246.

Gonçalves, E., Henkel, L., Kouvavas, O., Porqueddu, M. and Trezzi, R. (2021). 2021 HICP weights and their implications for the measurement of inflation. In *Economic Bulletin*, 7/2020, ECB, pp. 34–41.

Herzberg, J., Knetsch, T. A., Schwind, P. and Weinand, S. (2021). *Quantifying Bias and Inaccuracy of Upper-level Aggregation in HICPs for Germany and the Euro Area*. Discussion Paper 6/2021, Deutsche Bundesbank.

ILO, IMF, OECD, UNECE, Eurostat and World Bank (2004). *Consumer price index manual: Theory and practice*. Geneva: International Labour Office.

Insee (2020). How to compute a consumer price index in the context of the Covid-19 crisis? hiips://www.insee.fr/fr/statistiques/documentation/Data%20quality%20Covid19_FE_07_2020.pdf, accessed: 30 August 2021.

Konüs, A. A. (1939). The Problem of the True Index of the Cost of Living. *Econometrica*, **7** (1), 10–29.

Kouvavas, O., Trezzi, R., Eiglsperger, M., Goldhammer, B. and Gonçalves, E. (2020). Consumption patterns and inflation measurement issues during the COVID-19 pandemic. In *Economic Bulletin*, 2/2021, ECB, pp. 75–79.

Leifer, H.-A. (2002). Zur Eignung eines Verbraucherpreisindex und eines Lebenshaltungskostenindex als Inflationsmaßstab. *Allgemeines Statistisches Archiv*, **2000** (84), 67–82.

ONS (2020). Effect of reweighting the consumer prices basket during the coronavirus (COVID-19) pandemic: April to September 2020. hiips://www.ons.gov.uk/economy/inflationandpriceindices/articles/effectofreweightingtheconsumerpricesbasketduringthecoronaviruscovid19-pandemic/apriltoseptember2020, accessed: 30 August 2021.

von der Lippe, P. (1999). Kritik internationaler Empfehlungen zur Indexformel für Preisindizes in der amtlichen Statistik. *Jahrbücher für Nationalökonomie und Statistik*, **218** (3-4), 385–414.

— (2000). Der Unsinn von Kettenindizes. *Allgemeines Statistisches Archiv*, **2002** (86), 371–384.

— (2001). *Chain Indices: A Study in Price Index Theory*. Statistisches Bundesamt.

Walschots, J. (2016). *Contributions to and impacts on inflation*. The Hague: Statistics Netherlands.