2 Measuring inflation in the EU in times of COVID-19

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Abstract: The COVID-19 crisis had a major impact on the measurement of inflation around the world, as price observation in shops became impossible and some markets completely closed down. This article looks at the measures taken during the crisis in 2020 to ensure the continued compilation of the European harmonised index of consumer prices, which is the comparable measure of inflation produced in all EU Member States and the key inflation target measure for European monetary policy. We describe the various principles underlying the overall approach, its practical implementation and provide an analysis of the impact on the overall inflation rate from some of the choices made.

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([1])   Eurostat, Unit C4 — Price statistics, purchasing power parities, housing statistics.

1. Introduction

The coronavirus disease 2019 (COVID-19) outbreak led governments to impose several measures, such as restrictions on the movement of people and the closure of outlets. These measures had a negative impact on the collection of prices that are needed to compile consumer price indices since price collectors could no longer visit shops and several goods or services were no longer available on the market. National statistical institutes (NSIs) had to take emergency measures to ensure the continued compilation of price statistics in such unprecedented circumstances. In the European Union (EU), it was quickly realised that such measures needed to be coordinated in order to maintain the comparability of statistics, in particular of the harmonised index of consumer prices (HICP), which is the key inflation measure used for monetary policy by the European Central Bank (ECB).

Eurostat and NSIs therefore developed a common approach for the compilation of the HICP during the pandemic, based on a common set of principles. All European NSIs that compile an HICP have followed these principles. The adopted principles were communicated to users through the Eurostat website (Eurostat (2020a) and Eurostat (2020b)). Coordination also took place at international level, through the publication of a guidance note produced by the six institutions that constitute the Inter-Secretariat Working Group on Price Statistics (IWGPS (2020)).

The objective of this paper is to present the approach followed to handle the challenges that the pandemic and accompanying restrictions (hereafter referred to as the crisis) posed (and still poses) to the compilation of the HICP and to analyse the impact of the crisis on the HICP. This paper is structured as follows. Section 2 describes the chosen approach and its practical implementation. A particularly important aspect of the approach is the guidance provided on imputations, in other words, how to make estimates for prices of products that could not be collected or are not available. Section 3 analyses how the guidance on imputations was implemented between March and September 2020 and how the choices made affected the overall HICP for the euro area. Finally, Section 4 highlights some of the main lessons learned and provides some concluding remarks.

2. Chosen approach

In order to deal with the difficulties associated with the compilation of the HICP in the context of the COVID-19 crisis, Eurostat developed, together with NSIs of the EU Member States, a set of methodological guidance notes (Eurostat (2020a) and Eurostat (2020b)). Parallel to this, a new metadata reporting system on imputations was developed [2]. This section summarises the main principles underlying the approach that was followed to cope with market closures, price unavailability, and other problems that compilers of price indices had to face during lockdown and post-lockdown periods.

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[2] This metadata system is comprised of a file reporting information on imputations related to the COVID-19 crisis. The information taken from these files is summarised and published under the 'COVID-19 and HICP' section of the HICP methodology webpage (https://ec.europa.eu/eurostat/web/hicp/methodology).

2.1. Basic principles

The main principles guiding the response to the COVID-19 crisis are formulated in Eurostat (2020a). Although complemented by other guidance documents, this first note stands out as the backbone of the common response to the crisis. Three principles, each linked to one of the three building blocks of price indices (namely, prices, weights and indices), are explained in more detail below. A fourth principle, on transparency to users, is presented at the end of this section.

2.1.1. PRICES

The first principle simply underscores the idea that the number of imputed prices should be minimised. Following the outbreak of COVID-19, routine price collection activities started to fail. This happened because price collectors could no longer visit sampled outlets (because of government lockdowns or restrictions imposed to protect staff of NSIs), and because some services were no longer allowed to be offered (for example, flights or services provided by hairdressers).

The implementation of this principle meant that whenever possible, missing price observations should be replaced not by an imputation, as normally happens when a price is missing, but by prices from alternative data sources. In the case of manual price collection activities, obvious alternatives were to collect prices from outlet's websites, or by telephone and/or e-mail enquiries. The use of price information from scanner data (for those products where scanner data are not yet used) was another possible source for replacing some missing prices.

Of course, such strategies only worked in those cases where products continued to be transacted. In the case where sellers had to cease their activities and thus no transactions could take place at all, no alternative sources could be employed.

2.1.2. WEIGHTS

A second important principle was not to adjust the HICP weights during 2020 despite the impact of the COVID-19 crisis on expenditure. In fact, a key principle underlying the HICP compilation is that weights are kept fixed throughout the year. This is a consequence of the definition of the HICP as an annually chained Laspeyres-type index. HICP sub-indices are aggregated using weights reflecting the household final monetary consumption expenditure patterns of the previous year. HICP weights are updated every year, at the beginning of each year. These requirements are formalised in a Commission Implementing Regulation ([3]). Therefore, changing the HICP weights in the middle of the year would not have been consistent with the legal and conceptual framework of the HICP.

In addition to these considerations, it is unlikely that timely data sources to derive updated weights would have been available in a harmonised manner and with sufficient quality

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[3] Article 3 of Commission Implementing Regulation (EU) 2020/1148 of 31 July 2020 laying down the methodological and technical specifications in accordance with Regulation (EU) 2016/792 of the European Parliament and of the Council as regards harmonised indices of consumer prices and the house price index.

across all EU Member States. This is in line with international guidance, with the IWGPS ([4]) also discouraging Member States to make ad-hoc adjustments to the weights. Short-term adjustments to the weights or to the compilation methods would have created uncertainty about the way that the HICP is calculated. It would have generated practical problems and quality concerns all along the production process.

At the same time, it is widely acknowledged that consumption patterns have significantly changed because of the COVID-19 crisis. Several studies that mainly rely on credit card data (for example, Carvalho et al. (2020) and Cavallo (2020)) found that during lockdown periods, households spent relatively more on food and less on recreation services, restaurants, or travelling. Some of these changes persisted, to some extent, even after lockdown periods ceased as households adjusted their behaviour to the new situation. These developments pose challenges for users (see for example ECB (2020a)) as the official inflation figures do not instantaneously take into account such shifts in consumer behaviour.

Diewert and Fox (2020) discuss three practical proposals for compiling a consumer price index (CPI) under these circumstances, depending on data availability. A first scenario consists in calculating a price index by excluding from the basket those products that are unavailable. Technically, this is equivalent to setting the weights of unavailable products to zero and redistributing their weights across the remaining products in a proportional manner. Some of the simulations provided in Section 3.3 follow this scenario. A second scenario consists in updating the weights using additional data sources and linking in a new basket of goods and services. Technically, this corresponds to the procedure that is typically conducted in the HICP at the beginning of each year. In a third scenario, weights are updated every month and a (chained) Fisher price index is calculated. This is the most advanced scenario and requires monthly expenditure data.

More specifically, ECB (2020b) estimated monthly expenditure shares for the HICP using retail turnover data and calculated experimental Fisher price indices. The French statistical institute (INSEE) calculated Paasche-type indices by using a monthly weighting scheme derived from credit card data and other data sources (INSEE (2020)). A similar exercise was also conducted by the United Kingdom Office for National Statistics (ONS (2020)). Reinsdorf (2020) concludes that changing expenditure patterns during 2020 led to an underestimation of inflation in most countries.

([4]) The IWGPS notes the following: 'While COVID-19 has affected expenditure patterns, current expenditure data are not available, and ad hoc adjustments to the weighting structure are therefore not recommended. Ad hoc weight adjustments are not consistent with the fixed basket approach used as the basis for compiling consumer price indexes.'

2.1.3. COMPILATION OF INDICES

The third and last principle refers to the compilation of HICP sub-indices and the way the HICP is calculated from its lower-level building blocks into final inflation figures. Due to the crisis, prices for some categories of products, such as flights and international package holidays, were non-existent and indices based on observed prices could not be compiled. It was decided to compile the HICP on the principle that all sub-indices for the full European classification of individual consumption according to purpose (ECOICOP) structure should be compiled, even when for some categories of this classification, no prices and products were available on the market (Eurostat (2020a)). This decision should also be seen against the many important uses of the HICP, in particular for monetary policy and for contractual indexation of bonds, pensions, wages, and so on. In other words, not compiling the HICP or only partly compiling the HICP were not seen as feasible options.

It should also be noted that, in particular due to its use for contractual indexation, revisions to the HICP are generally to be avoided. Thus, filling in the missing prices afterwards, for example when new information becomes available or by backwards extrapolating prices observed post-lockdown, was not desirable either (for the same reason, it was not possible to revise indices retrospectively on the basis of new weights information).

The implementation of this principle implies that unavailable prices or price indices needed to be imputed [5]. The imputations that were used in the compilation of HICP sub-indices are described in Eurostat (2020b), pp. 3-7. These were divided into two broad categories: the first comprised methods applied to products for which it was possible to find products on the market (although their prices could not be observed), while the second included those applied for the imputation of products that were not transacted. In relation to this last group, the imputation of products known to follow pronounced seasonal patterns, such as package holidays or accommodation services, received particular attention in the note. Section 2.2 describes the different imputation methods in more detail.

[5] The choice of this approach also had the advantage of not imposing extra operational costs in the sense that it would not require an adaptation of national compilation systems, which had generally not been designed or were not flexible enough to cope with situations in which one or more sub-indices of the ECOICOP were absent from HICP compilation.

2.1.4. TRANSMISSION AND DISSEMINATION OF INFORMATION ON IMPUTATIONS

The need to inform users about the impact of COVID-19 and its accompanying restrictions on the HICP led Eurostat to develop a reporting system in which NSIs were asked to flag, in their HICP data transmission files and in a new metadata file, all indices considered to have been significantly affected by COVID-19 related imputations. This system was designed to provide relevant information without overburdening NSIs with new reporting demands, as they were already dealing with considerable problems associated with the compilation of their price indices.

More precisely, EU Member States were asked to flag sub-indices for which the share of imputations exceeded 50 %, either in terms of the weight of the imputations or in terms of the number of underlying price observations. Any such sub-index was flagged with a 'U' and regarded as having 'low reliability'. These flags were included in Eurostat's dissemination database and propagated to aggregate levels. European aggregates were flagged if more than 50 % (in terms of HICP weights (item weight for the Member State multiplied by the Member State's weight)) of their constituent indices were flagged.

As mentioned above, an additional metadata reporting file was developed to provide more information on imputations. This included information on the types of imputation methods used and NSIs also provided an indication of the share of imputations for sub-indices (in cases where a sub-index was identified with a 'U' flag) and for the overall index [6].

Information on imputation shares can be calculated either in terms of the number of prices or in terms of expenditure weights. For example, an imputed elementary aggregate within a subclass may represent 10 % of the weight of that subclass, but perhaps 20 % of the prices collected in that subclass. Although a preference was given to the reporting of imputation shares based on weights, NSIs were also given the option to provide imputation figures based on the number of prices. There was also the need to clarify some borderline cases on the definition of an imputation. For example, prices that were previously collected in the field were sometimes replaced with prices from an alternative data source. This treatment should, in principle, not be counted as an imputation if the data source was reliable enough to adequately portray price changes of the product (in other words, it had sufficient coverage of the market).

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[6]   The share of imputations in a specific country depends on national circumstances, such as the extent of COVID-19 related restrictions, price collection arrangements, index compilation practices, or the availability and use of alternative data sources.

2.2. Imputation and flagging of the data

As discussed in the previous section, in cases where prices were not available, they had to be estimated ([7]) so that a price index could still be compiled, as the weights were kept fixed. There are different imputation techniques that can be applied and these are discussed in Eurostat (2020a).

- **Same product or nearest aggregate imputation**
  This standard imputation technique consists in imputing the monthly price change for the missing prices based on the price change of the same or similar products (typically the price change of the nearest higher aggregate in the index hierarchy).
- **All reliable sub-indices imputation**
  In this method, the monthly change of an overall index based on all reliable sub-indices (in other words, those for which products are available on the market and a sufficient number of prices are observed) is used as a basis for imputation.
- **Carry forward imputation**
  This imputation technique consists in carrying forward the last observed price.
- **Seasonal pattern imputation**
  The prices of some products are known to follow pronounced seasonal patterns. Examples are flights, package holidays or accommodation services. The aim of this imputation method is to ensure that the imputations take into account the seasonal pattern of the series concerned.

A distinction was made between products that were still transacted in the market but where price collection failed, and products that were not transacted anymore.

In the first case, the recommendation was to use the same product or nearest higher aggregate imputations and, where justified, carry forward. In the second case, it was recommended to impute with all reliable price indices. The advantage of this approach was that, if applied to all sub-indices for which there was no market, the monthly price change of the all-items index was driven only by the price changes of reliable sub-indices. As a second best approach, carry forward could also be considered. Although carry forward is a transparent method that is easy to implement and to explain, its use makes price indices converge towards no price change. The more prices are imputed with carry forward, the more the all-items monthly price change converges towards zero.

Moreover, a special treatment was foreseen for unavailable products that normally have pronounced seasonal patterns. Using an imputation with all reliable sub-indices would most likely not preserve the seasonal pattern and could distort the annual rate of change. It was therefore agreed to impute prices so that the seasonal pattern of the series was preserved. In practice, the seasonal pattern could be preserved by basing the imputation on the annual rate of change observed for other products. A variant would be to estimate the monthly change of the seasonal index using the monthly change for the same index observed in the previous year, or, if possible, using seasonal factors obtained by estimating an econometric model.

([7]) Article 9 of Commission Implementing Regulation (EU) 2020/1148 foresees the use of estimated prices for the HICP in those cases where prices cannot be observed.

Table 1, which is taken from IWGPS (2020), illustrates the outcomes of different imputation methods for a seasonal product. It was critical that the imputations for products with seasonal patterns were implemented in a harmonised way by the EU Member States.

Table 1: Imputation for items with strong seasonal pricing patterns

	2019		2020	
	March	April	March	April
All-items excluding accommodation services	100.0	100.5	102.0	**103.5**
Monthly rate of change				*1.5 %*
Annual rate of change				*3.0 %*
Option 1: All reliable sub-indices imputation				
Accommodation services	100.0	112.0	101.0	101.0 * 103.5 / 102.0 = **102.5**
Monthly rate of change				*1.5 %*
Annual rate of change				*−8.5 %*
Option 2a: Seasonal pattern imputation (imputing with the annual rate of change of all reliable sub-indices)				
Accommodation services	100.0	112.0	101.0	112.0 * 103.5 / 100.5 = **115.3**
Monthly rate of change				*14.2 %*
Annual rate of change				*3.0 %*
Option 2b: Seasonal pattern imputation (imputing with the monthly rate of change from the previous year for accommodation services)				
Accommodation services	100.0	112.0	101.0	101.0 * 112.0 / 100.0 = **113.1**
Monthly rate of change				*12.0 %*
Annual rate of change				*1.0 %*

2.3. Issues emerging from the lifting of lockdown measures

Eurostat (2020b) identified five issues stemming from the gradual lifting of the initial restrictions in the EU. The first issue revolved around the renewed availability of prices for products that were not on the market. As described above, prices were imputed during the lockdown because products were unavailable or because prices could not be collected in the field. As actual prices became observable again, it was emphasised that the imputation methods that had been used should be self-correcting, meaning that the change between the last pre-lockdown price and the first post-lockdown price should be correctly captured, independently of the prices imputed during the lockdown.

Two other issues that were identified in Eurostat (2020b) were the existence of COVID-19 related fees associated with the provision of certain products (for example reservation fees in restaurants) and changes in the quality of products. As a rule, extra charges were taken into account and recorded as a price increase in the HICP whenever it was not possible to obtain the product without the payment of the additional charge. Moreover, decisions on whether a price should be quality adjusted were to be made on a case-by-case basis, keeping in mind that, since the direction of quality changes can have contradictory signs, the estimation of the magnitude of the quality change could be difficult to estimate in practice.

The two last issues discussed in Eurostat (2020b) clarified that the target sample of the HICP could be updated to include newly significant products such as face masks and disinfectant, and discussed how services that become available again but in a very different market situation (for example air travel, package holidays, accommodation services) could be treated.

2.4. HICP weights for 2021

As discussed in Section 2.1.2, the HICP is an annually chain-linked Laspeyres type index. This implies that the weights of the sub-indices need to remain fixed during the year, but are updated at the beginning of each year. The weights need to be representative for the year prior to the current year, in other words, *t-1*. Thus, HICP weights that are used in 2021 should be representative of household consumption expenditure for 2020.

In practice, national accounts data for year *t-2* are used as the basis to estimate expenditure shares for *t-1*. In normal times, structural changes between *t-2* and *t-1* are limited so that *t-2* data can be used to approximate *t-1*. Clearly, this is not the case when consumption expenditure changes significantly, both in level and structure, between *t-2* and *t-1*, such as during the current crisis.

NSIs thus have to make an additional effort to produce the best estimates possible for household consumption expenditure patterns in 2020. These should be based partly on preliminary data for quarterly national accounts, complemented by other short-term statistics related to, for example, retail trade, services, tourism, energy and transport. Scanner data, credit card data or data from high-frequency household budget surveys may also be used. Eurostat (2020c) provides guidance to NSIs on the estimation process, in order to ensure the comparability of the results.

3. Analysis of COVID-19 imputations

This section summarises and explores the information collected on imputations between March and September 2020. The analysis is based on data published on Eurostat's website ([8]).

3.1. Imputation shares

NSIs provided Eurostat with information on the share of imputations for sub-indices flagged with a 'U', as well as for the all-items index. Based on this detailed reporting, Eurostat estimated the share of consumption expenditure in the all-items basket for European aggregates that was imputed due to the COVID-19 crisis. The calculations followed a two-step approach. First, based on the best available information, shares for the main special aggregates were calculated for each EU Member State. These shares were then combined taking into account weights for the Member States. Figure 1 shows the development of imputation shares from April to July 2020 (the months for which information on the imputation shares for the all-items index was collected).

Figure 1: Imputation shares for the all-items HICP and selected special aggregates, euro area (%)
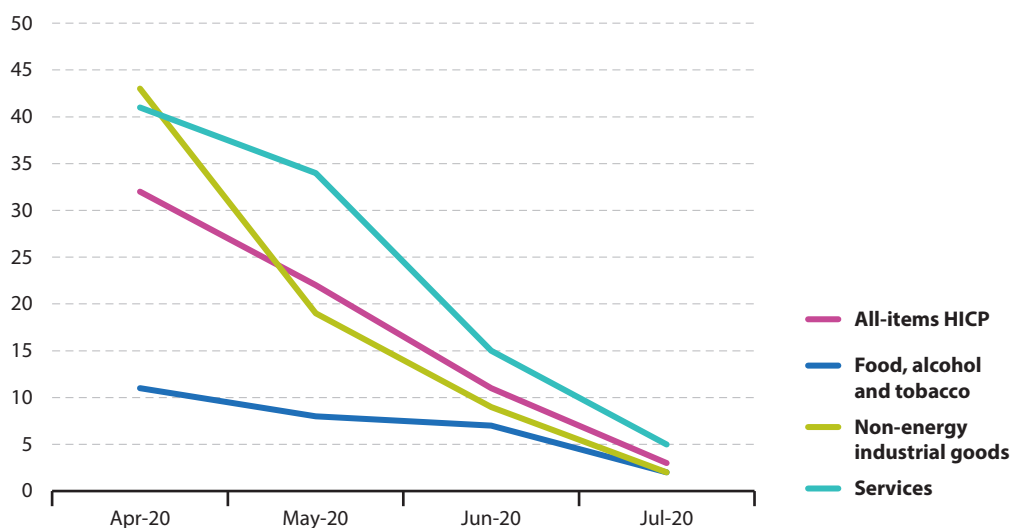
As Figure 1 shows, the imputation shares for the all-items HICP peaked in April 2020, at the height of the lockdowns, when more than 30 % of the index was composed of imputations. This share had decreased to 3 % by July 2020, by when many of the restrictions (from the first wave of the crisis) had been lifted. The index for services was generally the most affected in terms of the imputations share.

([8]) Data for the imputations are available at https://ec.europa.eu/eurostat/web/hicp/methodology under 'COVID-19 and HICP'.

3.2. Data on imputations

As explained above, a 'U' flag was used to identify HICP sub-indices for which the share of imputations, in terms of weight or the number of prices, exceeded 50 %. These were the HICP components that were most affected (in terms of availability) by the COVID-19 crisis and it is possible to characterise the impact of these imputations on the compilation of the HICP. Table 2 gives an overview of the development of 'U' flags in euro area countries from March 2020 — the month in which COVID-19 first started to cause problems for price index compilers — to September 2020.

Table 2: Overview of 'U' flags for HICP sub-indices, euro area

		Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20
Number of 'U' flagged sub-indices (count)		49	942	430	165	37	31	24
Share of 'U' flagged sub-indices in the total number of sub-indices (%)		0.9	16.8	7.7	2.9	0.7	0.6	0.4
Broken down by ECOICOP division **Share of 'U' flagged sub-indices in the total number of sub-indices (%)**								
01	Food and non-alcoholic beverages	0.3	3.6	1.1	0.3	0.0	0.0	0.0
02	Alcoholic beverages, tobacco	0.0	2.0	0.4	0.0	0.0	0.0	0.0
03	Clothing and footwear	3.9	38.6	11.0	2.6	0.0	0.0	0.0
04	Housing, water, electricity, gas and other fuels	0.0	9.2	3.9	0.7	0.0	0.0	0.0
05	Furnishings, household equipment and routine household maintenance	0.7	22.4	7.4	1.8	0.0	0.0	0.0
06	Health	0.0	16.5	5.6	1.9	0.0	0.0	0.0
07	Transport	0.9	16.7	9.2	5.5	1.3	0.9	0.9
08	Communication	0.0	3.3	1.0	1.0	0.0	0.0	0.0
09	Recreation and culture	1.1	23.2	13.0	6.3	2.2	1.9	1.5
10	Education	2.6	21.9	14.0	6.1	0.9	1.8	0.9
11	Restaurants and hotels	4.4	62.3	50.0	16.7	3.5	3.5	1.8
12	Miscellaneous goods and services	1.5	24.0	9.3	2.5	0.5	0.2	0.2

Note: the figures shown refer to 'U' flags reported by individual euro area countries, rather than for the euro area aggregate itself.

As Table 2 shows, April 2020 stood out as the month in which the level of imputations had its biggest impact on the compilation of the euro area HICP. For this month, 16.8 % of euro area sub-indices had more than 50 % of their weight or prices imputed due to reasons associated with the COVID-19 crisis. In March 2020, the level of imputations had not been so large, reflecting the fact that, with the exception of Italy, most of the euro area countries were able to complete their price collection activities in a fairly normal way during the first half of the month.

On a more disaggregated level, the ECOICOP divisions that were most affected by imputations in April 2020 were: restaurants and hotels (62.3 %), clothing and footwear (38.6 %), miscellaneous goods and services (24.0 %) and recreation and culture (23.2 %).

Table 3 provides information on the 10 HICP sub-indices that were most affected by imputations in April 2020.

Table 3: Sub-indices with the highest percentage of 'U' flags, euro area
(%)

ECOICOP	Description	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20
07.3.3.2	International flights	10.5	94.7	94.7	84.2	15.8	15.8	15.8
09.4.2.1	Cinemas, theatres, concerts	5.3	89.5	89.5	73.7	36.8	31.6	10.5
09.6.0.2	International package holidays	15.8	89.5	94.7	94.7	47.4	47.4	52.6
11.2.0.1	Hotels, motels, inns and similar accommodation services	10.5	84.2	84.2	31.6	5.3	5.3	5.3
12.1.1.2	Hairdressing for women	5.3	84.2	26.3	5.3	0.0	0.0	0.0
09.4.2.2	Museums, libraries, zoological gardens	5.3	78.9	47.4	5.3	0.0	0.0	0.0
12.1.1.1	Hairdressing for men and children	5.3	78.9	26.3	5.3	0.0	0.0	0.0
12.1.1.3	Personal grooming treatments	5.3	78.9	26.3	5.3	0.0	0.0	0.0
09.4.1.1	Recreational and sporting services — attendance	10.5	73.7	73.7	31.6	15.8	10.5	10.5
09.4.1.2	Recreational and sporting services — participation	0.0	73.7	73.7	21.1	5.3	5.3	0.0

Note: the figures shown refer to the 10 sub-indices with the highest share of 'U' flags, as measured by the number of 'U' flags across euro area countries divided by the total number of sub-indices for euro area countries in April 2020.

Unsurprisingly, this ranking includes some of the activities that were most impacted by the implementation of restriction measures. These include, on the one hand, services that are associated with travelling and tourism (international flights, package holidays and accommodation services) and, on the other, the provision of leisure and recreation services (for example provided by cinemas, theatres, concerts and museums) and services associated with personal care (for example, those provided by hairdressers). In September 2020, there were still a considerable number of national price indices for international package holidays that were impacted by imputations and flagged with a 'U' (52.6 %); this was a slight increase in relation to the previous month (47.4 %).

The data collected on imputations also included information on the particular type of imputations made. Table 4 provides a summary of the number of times each one of the methods was used from March to September 2020 in euro area countries.

Table 4: Count of imputation methods by ECOICOP division, euro area (number)

Imputation method	ECOICOP division												
	01	02	03	04	05	06	07	08	09	10	11	12	Total
Based on same product	51	4	49	12	135	5	34	10	115	2	13	42	472
Based on nearest aggregate	5	2	23	3	10	4	12	0	22	3	21	10	115
Based on all reliable sub-indices	0	0	11	14	14	4	22	0	51	6	5	27	154
Based on carry forward	0	0	32	20	85	42	24	1	169	35	55	119	582
Based on seasonal pattern	0	0	12	9	0	1	92	0	120	0	65	5	304
Other	6	0	0	0	0	6	0	0	7	7	2	5	33
Information not provided	0	0	1	2	1	2	5	0	2	2	1	2	18
Total	62	6	128	60	245	64	189	11	486	55	162	210	1 678

Note: for a description of the imputation methods, see section 2.2. For the designation of the ECOICOP divisions, see Table 2.

Imputation based on carry forward and imputation based on available prices for the same product were the two imputation methods that were most often used during the period under consideration (582 and 472 times, respectively). As may be expected, imputation based on a seasonal pattern was most often applied in recreation and culture (120 times), transport (93), and restaurants and hotels (64). These divisions included components with strong seasonal patterns, such as international flights, package holidays and accommodation services.

3.3. Impact of the imputations

In order to assess the impact of the imputations that were made for the HICP, an experimental index was calculated, which assumed that all sub-indices with 'U' flags were imputed using carry forward. Another experimental index was calculated based on an adjusted basket of goods and services that excluded the sub-indices with 'U' flags. Note that all of the simulations presented in this section are consistent with standard HICP compilation procedures.

In the first simulation, an experimental index was calculated where, successively in each month, all sub-indices with 'U' flags were replaced by their index value of the previous month. This provides a contrast with the published sub-indices with 'U' flags that were based on different imputation methods and that sometimes included a combination of both estimated and observed prices. A euro area HICP derived solely from using such a carry forward imputation mechanism would have resulted in lower inflation rates. Adopting carry forward on such a large-scale would have had a significant dampening effect on annual inflation rates.

The second simulation consisted of excluding all the sub-indices with 'U' flags from the basket of goods and services used to compile the HICP ([9]). Note that the set of sub-indices with a 'U' flag varied from one EU Member State to another, and from one month to the next. Therefore, the basket underlying the index compilation also changed from one month to another. For example, for March 2020, an index was compiled based on a basket that excluded all of the sub-indices with a 'U' flag for March 2020. The following month, the basket was updated by excluding the 'U' flags reported for April 2020, and so on. Excluding the sub-indices with 'U' flags was equivalent to setting the weights for these products to zero. The weights of the remaining products relative to each other were kept unchanged. Again, annual inflation rates for the euro area derived from baskets restricted in this way were lower than the published annual rates for the HICP, but the impact was less than for an HICP based on carry forward imputations (see Figure 2).

Figure 2: Annual rates of change for the published HICP and alternative measures, euro area (%)
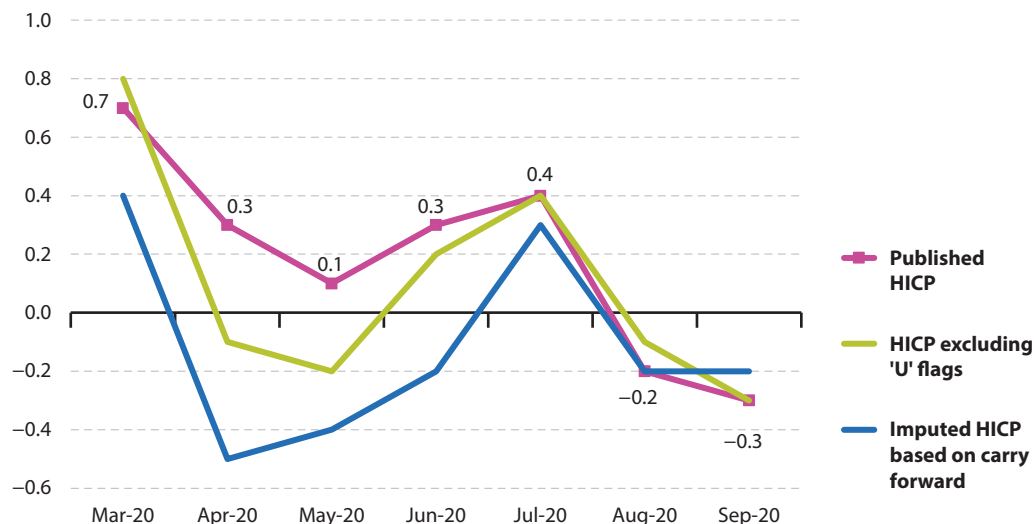

The published annual rates of change for the all-items HICP can be decomposed into contributions with respect to three components: (i) the sub-indices not flagged with a 'U'; (ii) the sub-indices flagged with a 'U' that were imputed using a seasonal pattern; and (iii) the sub-indices flagged with a 'U' that were imputed using another imputation method. This analysis confirms that the contribution to the published annual rates from sub-indices imputed using a seasonal pattern was very limited. Figure 3 shows that despite the quite pronounced month-on-month changes in prices for products with a seasonal pattern, the impact on the annual rate was rather limited.

([9]) Technically, only the lowest-level sub-indices were considered in this analysis. The all-items HICP can be obtained as a weighted average of these lowest-level sub-indices. Instead of summing over all of the lowest-level categories of the ECOICOP, an index was derived from the lowest-level sub-indices that did not have a 'U' flag.

A different picture was obtained when decomposing the price change with respect to December 2019. Price changes compared with this fixed reference period included seasonal effects. In comparison to the contributions to the annual rate of change, there was now a larger, and usually positive, contribution of seasonally imputed sub-indices (see Figure 4).

Figure 3: Contribution of imputations to annual changes in the HICP, euro area
(%)
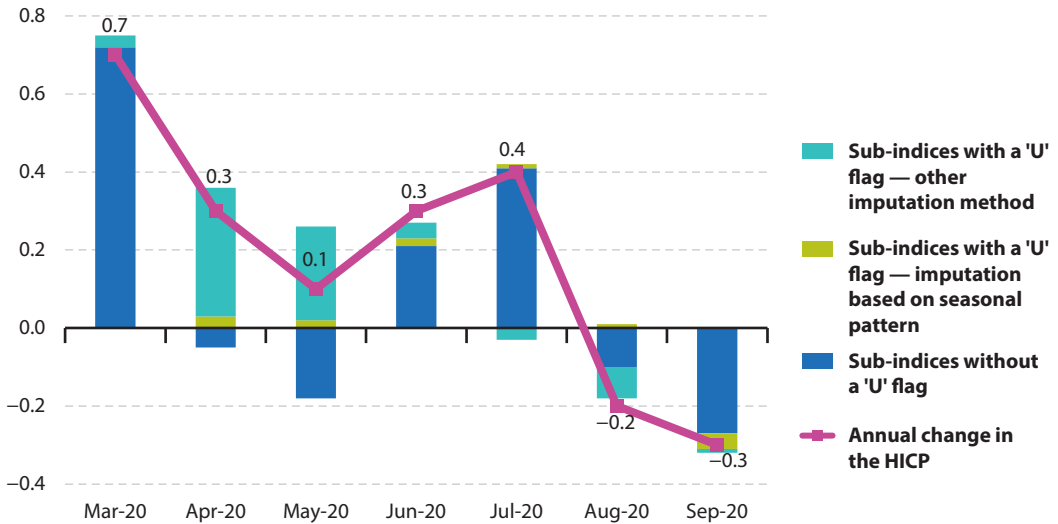
Note: the rate of change is based on the HICP for a particular month compared with the same month of the previous year.

Figure 4: Contribution of imputations to changes in the HICP compared with December 2019, euro area
(%)
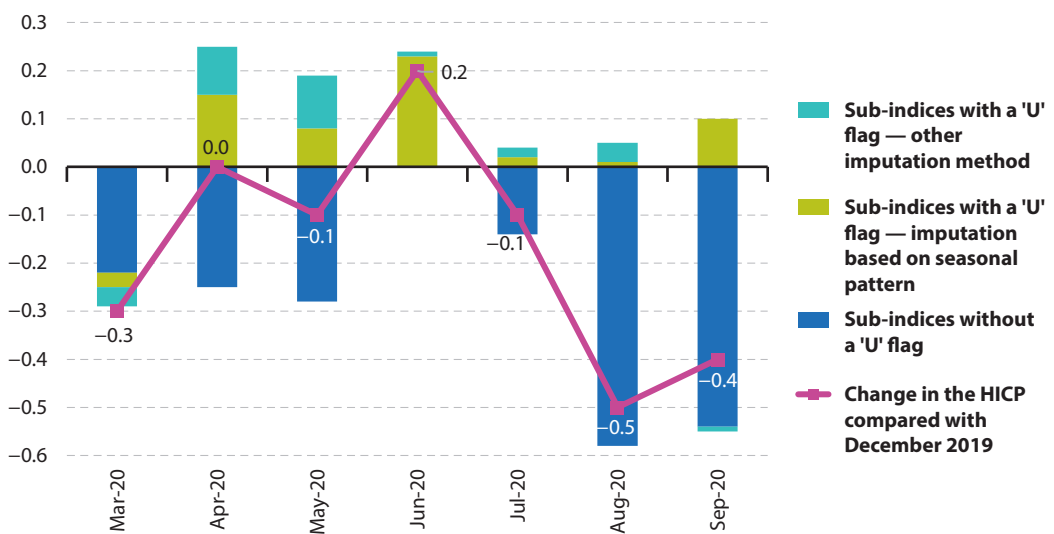
Note: the rate of change is based on the HICP for a particular month compared with the HICP for December 2019.

4. Conclusions

Despite the huge and complex challenges posed by the COVID-19 crisis, NSIs across the EU Member States have continued to compile the HICP. It was decided at an early stage of the crisis that maintaining the full set of HICP sub-indices was essential for users, even if this meant that a significant share of indices would need to be imputed. As a consequence, users needed to be fully informed about the imputations made and the impact of the crisis on the HICP. NSIs thus compiled and delivered detailed and comprehensive metadata on imputations that they made and these were published on Eurostat's website.

These metadata show that the impact of the crisis on the HICP was indeed significant: at the height of the first wave of the crisis, in April 2020, around 30 % of the HICP for the euro area was imputed. This share decreased steadily (during and after the first wave of the crisis) and by September 2020, the main sub-indices that continued to be imputed included those for international flights, for cinemas, theatres and concerts, and for package holidays.

The impact of imputations on the all-items HICP, measured as the difference between the official (published) index and an index that excluded imputed sub-indices, was most significant (during the first wave of the crisis) for the months of April and May 2020. The chosen imputation method for seasonal products ensured that imputations did not materially affect annual inflation rates.

NSIs were innovative in finding alternative data sources for the prices of products that were still being transacted, but could not be collected in the normal way. This was particularly true for data collected from the internet, either by web scraping or manually, while scanner data were also used. Some of these data sources continued to be used after the end of the first wave of the crisis.

The COVID-19 crisis has shown that NSIs need to have contingency plans in case of calamities. In particular, information technology systems for statistical data collection and compilation have been tested and any resulting weaknesses need to be addressed. Given the unprecedented nature and scale of the COVID-19 crisis, it can be concluded that NSIs have shown their resilience and that the HICP has, so far at least, weathered the storm.

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