UPDATING CPI WEIGHTS AND LINKING NEW TO PREVIOUS CPI SERIES

9

Introduction

9.1 Consumer price index (CPI) weights should be updated on a periodic basis (see Chapter 3). The preferred interval is at least once every five years. This chapter discusses the processes and procedures for introducing a new basket and corresponding weights in the CPI as well as approaches for linking the new and previous CPI series following the introduction of new weights. It includes examples of the steps involved in linking CPI series with different price reference periods, methods to keep the current index reference period or shift to a new one and explores whether interim or partial weight updates might be implemented in the period between major surveys such as a Household Budget Survey (HBS).

Calculating a Chain Index

9.2 Assume that a series of fixed weight Young indices has been calculated with period 0 as the price reference period and that in a subsequent period, k, a new set of weights has to be introduced in the index. The new set of weights may, or may not, have been price-updated from the new weight reference period to period k. A chain index is then calculated as:

$$\begin{aligned} I^{0:t} &= I^{0:k} \sum w_j^k I_j^{k:t-1} I_j^{t-1:t} \\ &= I^{0:k} \sum w_j^k I_j^{k:t} \\ &= I^{0:k} I^{k:t} \end{aligned} \tag{9.1}$$

9.3 There are several important features of a chain index:

- The chain index formula allows weights to be updated and facilitates the introduction of new items and sub-indices and the removal of obsolete ones.
- In order to be able to chain the old and the new series, an overlapping period (k) is needed in which the index has to be calculated using both the old and the new set of weights.
- A chain index may have two or more links. In each link, the index may be calculated as a fixed weight index using equation 9.1, or indeed using any other index formula. The chaining period may be a month or a year, provided the weights and indices refer to the same period.
- Chaining is intended to ensure that the individual indices on all levels show the correct development through time.
- Chaining leads to non-additivity so that chained indices at the lower-level cannot be aggregated into indices at higher level using the latest set of weights. If, on the other hand, the index reference period is changed and the index series prior to the chaining period is rescaled to the new index reference period, this series cannot be aggregated to higher-level indices by use of the new weights.

9.4 An example of the calculation of a chain index is presented in Table 9.1. From 2008 to December 2016 the index is calculated with 2008 as weight and price reference period. From December 2016 onwards, a new set of weights is introduced. The weights may refer to the year 2014, for example, and may or may not have been price-updated to December 2016. A new fixed weight index series is then calculated with December 2016 as the price reference month.

Table 9.1 Calculation of a Chain Index

	Weight 2008	2008	Nov. 2016	Dec. 2016	Weight 2016	Dec. 2016	Jan. 2017	Feb. 2017	Mar. 2017
		2008 = 100				*December 2016 = 100*			
1. Elementary price indices									
A	0.20	100.00	120.00	121.00	0.25	100.00	100.00	100.00	102.00
B	0.25	100.00	115.00	117.00	0.20	100.00	102.00	103.00	104.00
C	0.15	100.00	132.00	133.00	0.10	100.00	98.00	98.00	97.00
D	0.10	100.00	142.00	143.00	0.18	100.00	101.00	104.00	104.00
E	0.30	100.00	110.00	124.00	0.27	100.00	103.00	105.00	106.00
Total		100.00	119.75	124.90		100.00	101.19	102.47	103.34
2. Higher-level indices									
G=A+B+C	0.60	100.00	120.92	122.33	0.55	100.00	100.36	100.73	101.82
H=D+E	0.40	100.00	118.00	128.75	0.45	100.00	102.20	104.60	105.20
Total		100.00	119.75	124.90		100.00	101.19	102.47	103.34
3. Chaining of higher-level indices to 2008 = 100									
G=A+B+C	0.60	100.00	120.92	122.33	0.55	122.33	122.78	123.22	124.56
H=D+E	0.40	100.00	118.00	128.75	0.45	128.75	131.58	134.67	135.45
Total		100.00	119.75	124.90		124.90	126.39	127.99	129.07

Finally, the new index series is linked onto the old index with year 2008 = 100 by multiplication to get a continuous index from 2008 to March 2017. The chained higher-level indices in Table 9.1 are calculated as:

$$I^{2008:t} = I^{2008:Dec2016} \sum w_j^{2008(Dec2016)} I_j^{Dec2016:t} \qquad (9.2)$$

9.5 Because of the lack of additivity, the overall chain index for March 2017 (129.07), for example, cannot be calculated as the weighted arithmetic mean of the chained higher-level indices G and H using the weights that was introduced from December 2016.

Updating Weights for Price Change: Pros and Cons

Approaches to Updating Weights

9.6 An issue that National Statistical Offices (NSOs) face in conducting revisions of the CPI is the timeliness of the data on weights and their introduction in the CPI. Typically, a HBS or other expenditure survey collects data during a prior year to the current time period. While the expenditure data from the HBS are the most commonly used source for developing weights, alternative sources can be used. For example, national accounts data. Alternative sources for developing weights are discussed in more detail in Chapter 3. Thus, the period to which the weights refer precedes the current period and the NSO cannot produce one of the target indices that require weights for the current period. When the weights are introduced, the price reference period precedes the current period and the time period over which the weights will be used extends beyond the current period. Thus, there is a continuum for the life cycle of the CPI that begins at a point in the past and continues to a point in the future, as illustrated in Figure 9.1.

9.7 The index must have a period to which the weights refer, the *weight reference period b*, when the expenditure data are collected over a period of months or quarters, usually for a year. The results of the survey are processed, compiled to provide estimates of expenditures by detailed products to establish elementary aggregates, and introduced in the CPI. In addition, the index must have a starting point, the *price reference period 0*, to which future prices will be compared in *current periods t*. The CPI will continue through time to its end point *T* after which a new set of weights, products, and prices will be introduced. Finally, the index must have a *index reference period* which is the period when the index is set to 100.

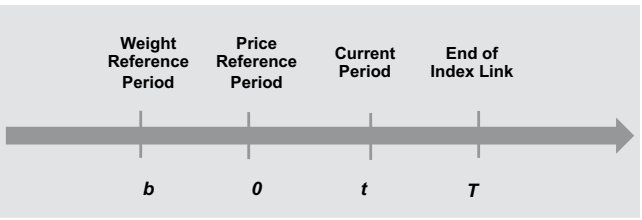
9.8 When introducing the new weights, NSOs must decide which method to use. There are two main options for updating the CPI weights: (i) price-updating the weights to the price reference period (Lowe index) to keep the implied quantities fixed at the weight reference period levels; or (ii) simply introducing the new weight structure (Young index) which keeps the expenditure shares fixed. This chapter examines what the choice of the updating method should be, using some objective criteria.

9.9 The target index for the CPI can be a Laspeyres price index which is easy to explain to users. It is a fixed quantity basket price index, with quantities held fixed in the price reference period. Alternatively, the target index for the CPI could also be the Fisher, Törnqvist, or Walsh price indices. Chapter 4 in *Consumer Price Index Theory* demonstrates that these three indices produce essentially the same results in practice. The Laspeyres index formula, however, is not generally used in practice. This is because the weight reference period, the period to which the expenditure weights refer, is generally earlier than the price reference period of the CPI. To derive an index that commences from its price reference period but keeps quantity weights fixed based on the earlier weight reference period, many NSOs would price update the earlier weights. In this way, the resulting Lowe index was often referred to as a "Laspeyres-type index." This raises the question of which index currently produced by NSOs would best approximate the target indices: the Lowe index with price-updated weights, or the Young index that simply uses the weights from the weight reference period.

9.10 For example, the European Union Harmonized Index of Consumer Prices (HICP)[1] is defined as a Laspeyres-type index where the weight reference period is year t-1 and the price reference period is December of year t-1. In practice, year t-1 expenditure data are not available, thus weights are derived using preliminary national accounts data referring to year t-2. The observed year t-2 expenditure may, or may not, be price updated between year t-2 and year t-1. The objective is to obtain the best possible estimate of the expenditure shares for the year t-1. If goods and services are perfect complements (i.e. there is no substitution between them and they are consumed in fixed proportions), the best approximation would be the price-updated weights. If goods and services are substitutes at such a rate that expenditure on one product relative to another is independent of the relative prices, the preferred approach would be not to price-update. It is possible to evaluate retrospectively which of the two options performs better by comparing the outcomes with that from using actual expenditure shares when they become available. The degree of substitution may vary across products, so the choice between these two options is not necessarily straightforward. In any case, the estimate of the expenditure shares for the year t-1 are always price-updated to the price reference period, December of year t-1.

9.11

Figure 9.1 The CPI Life Cycle



Should NSOs Use the Lowe or the Young Index (To Price Update or Not)?

9.12 In Chapter 3 of *Consumer Price Index Theory* various axioms are used to measure the performance of different price index formulas. From an axiomatic point of view, the Lowe

[1] See also *Harmonized Index of Consumer Prices (HICP) Methodological Manual,* Section 3.5, https://ec.europa.eu/eurostat/web/products-manuals-and-guidelines/-/KS-GQ-17-015

index performs better than the Young index. Of the twelve tests used, the Lowe passes all, while the Young index passes ten, failing the time reversal and the circularity tests. Thus, some NSOs consider the Lowe index preferable to the Young index.

9.13 The recent research cited suggests that price updating weights before introducing them in the CPI may not be the best approach for the CPI based on the performance of the resulting index formula when compared to the preferred target indices. Price-updating the expenditure shares does not imply that the resulting weights are necessarily more up to date. When there is a strong inverse relation between movements of price and quantities, price-updating on its own could produce unreliable results. For example, assume the price of beef increases relative to the price of chicken. If the quantities are held fixed while the prices are updated, the resulting expenditure weights for beef would increase substantially while the expenditure weights for chicken would decrease. In fact, consumers would spend less on beef and spend more on the relative less expensive chicken; however, because the quantities are fixed and the changes in relative expenditure are not reflected by price updating.

9.14 By price updating, the weights are aligned to the same reference period as the prices. If the NSO decides to price update the weights, the resulting index will be a Lowe index. The Lowe index is a fixed basket index, which from period to period measure the value of the same (annual) basket of goods and services.

9.15 Not price-updating the weights results in the calculation of a Young index. The Young index keeps the expenditure shares fixed in the expenditure survey period *b*. The Young index is a *fixed weight index* where focus is that the weights should be as representative as possible for the average value shares of the period covered by the index.

9.16 By keeping the expenditure shares constant from the weight reference period to the price reference period the underlying quantities are assumed to vary in response to changes in relative prices. Hence, if households tend to keep constant expenditure shares by substituting from goods or services with relative price increases to goods or services with relative price decreases, the period *b* expenditure shares will be good estimates of the expenditure shares in the price reference period when the weights are introduced in the index. In turn, if expenditure shares stay unchanged, the Young index will be a good estimate of a target superlative index. However, if quantities tend to remain constant (i.e., the households do not substitute between goods and services in response to relative price changes), the Young index will be biased downwards compared to a superlative target index.

9.17 Whether a Young or Lowe index is the better estimate of a superlative target index depends on whether the original or the price-updated weights are the better estimate of the average expenditure shares from 0 to *t.* Normal consumer behavior suggests that in general some substitution should be expected, so that the Lowe index will tend to be biased upward compared to a superlative target index. As the Young index allows for some substitution from *b* to *0,* while Lowe does not, it may be argued that the traditional Laspeyres bias to some degree is reduced in the Young index as compared to the Lowe index. Thus, to omit price-updating may be one practical way in which to reduce this type of bias.

9.18 Both quantities and expenditure shares change through time and progressively more, the longer the elapse of time between the weight reference period and the period when the weights are introduced in the index. Thus, whether the weights are price-updated or not, they should be reviewed and updated as frequently as possible to reduce potential bias. When rapid changes take place in relative quantities as well as relative prices, NSOs are effectively obliged to change the expenditure weights more often. Price-updating on its own cannot cope with this situation. The weighting basis must be updated with respect to both quantities and prices, which, in effect, implies that new weights have to be included.

Recent Research on Price-updating Expenditure Weights

9.19 Economists make certain assumptions about normal consumer behavior based on observation and economic theory. Both indicate that in response to relative price change consumers will adjust the quantities of goods and services they purchase. When the price of a product rises relative to other similar products, consumers will usually reduce the amount purchased of the product with the relatively higher price increase and purchase more of the similar products with the relatively lower price increases. The opposite phenomenon will occur as relative prices fall—consumers purchase more of the product with the relative decline in prices and less of the products with the relative price increases. This consumer reaction to price movements, known as substitution, is the theory underlying the downward sloping demand curve.

9.20 Given this behavior, Chapter 4 in *Consumer Price Index Theory* outlines why the Laspeyres price index will be an upper bound to the true cost-of-living index (COLI) and the Paasche price index will be a lower bound. It also shows subsequently that the three target indices—Fisher, Törnqvist, and Walsh—are very close approximations to one another and to the true COLI.

9.21 The Lowe index, like Laspeyres, assumes that consumers do not substitute away from items with relatively large price increases; the relative quantities are fixed at the weight reference period (*b*). In practical terms this means that items with relatively large increases in price gain an unduly large expenditure share in period 0 relative to period *b* (where *b* precedes 0). Balk and Diewert (2003), Balk (2010), and Chapter 4 in *Consumer Price Index Theory* show that the Lowe index has an upward substitution bias compared to the true COLI. This bias increases the longer the period between the weight reference period (*b*) and the price reference period (0). Chapter 4 in *Consumer Price Index Theory* also notes that the Lowe index is upwardly biased relative to the Laspeyres index. Thus, price updating the weights results in an index number that is upward biased relative to the target indices, as well as the Laspeyres index.

9.22 The dispersion of price change over the period affects the magnitude of the substitution bias. In the unlikely event that all prices change in the same proportion, there will be no bias from using the Lowe index rather than Laspeyres. The price-updated weights will be the same as the weights in the weight reference period. However, if prices are trending upward with normal consumer substitution behavior, the dispersion in prices is expected to increase and price-updating would have a substantial effect on the weights. This implies the bias in the Lowe index would be larger than if there were little price change. In general, prices tend to trend upward

over time and therefore it is clear that price updating weights from period *b* to 0 will result in an upward bias compared to the target indices (and the Laspeyres index also).

9.23 An alternative approach would be to use the weights from the weight reference period directly. Boldsen Hansen (2006) argues for using the Young index. Keeping the expenditure shares fixed at the weight reference period level means that there has been no change in weights between *b* and 0. Unchanging weights is consistent with consumer substitution behavior that exhibits unitary elasticity—consumer shifts in reducing the quantities purchased are in the same proportion as the increase in prices.

9.24 Whether the Young index is biased relative to the Laspeyres index will depend on the long-term trend in prices and the elasticity of substitution.[2] In general, the long-term trend in prices for most items has been positive. Given this trend, if the elasticity is lower than one (inelastic), the Young index may have a downward bias compared to the Laspeyres. This occurs because consumers on average do not substitute as much in response to price changes as the Young index implies. They tend to purchase the relatively higher priced items in greater quantities than implied by unitary elasticity. If the elasticity is greater than one (elastic), the Young index may have an upward bias compared to the Laspeyres, because consumers tend to substitute more than assumed. This is presented in more detail in Chapter 2 of *Consumer Price Index Theory*.

9.25 Recent studies of the potential bias in the Young and Lowe indices indicate that measured price changes using the Lowe index generally exceed those of the Young index and both exceed the target indices. Boldsen Hansen (2007) using Danish CPI data, Greenlees and Williams (2010) and Armknecht and Silver (2013) using United States (US) CPI data, Pike *et al* (2009) with New Zealand CPI data, and Huang, Wimalaratne, and Pollard (2016) using Canadian CPI data all verify that the CPI price changes measured using the Lowe exceed those of the Young index, and both are greater than those of the Törnqvist index.

9.26 Armknecht and Silver (2013) also suggests that there are practical solutions that might be used to simulate a target index. This study provides evidence from the methodology proposed by Lent and Dorfman (2009) that using the geometric average of arithmetic indices, such as Young or Lowe, with geometric indices such as geometric Lowe or geometric Young, respectively, can closely approximate the Fisher or Törnqvist indices. NSOs should be able to produce these four indices using the expenditure data available from the HBS. First, the NSO can calculate the Young and Lowe indices with the HBS weights and the price-updated weights. Next, the NSO can calculate the geometric Young and geometric Lowe by using the geometric aggregation formula (e.g., by taking a weighted average of natural logarithms of price relatives and converting the logarithm back to an index number). The NSO can then test which combination of the resulting arithmetic and geometric versions provide the best approximation to the Fisher or Törnqvist indices.

[2] Often the Laspeyres price index is the target index for countries' CPI so the comparison is made first to the more standard target then to the superlative index targets (Fisher, Törnqvist, or Young).

Detailed Methods for Updating Weights

Decide on Price Reference Period for Calculating the Updated CPI

Annual Price Reference Periods

9.27 As the new weights are developed from the HBS or alternative sources for weights such as national accounts data, the NSO must decide on what time period to use for the new price reference period. Often the choice is between a single period of less than a year (month or quarter) that is close to the current period or a yearly average. In either case, the price reference period should immediately precede the introduction of the new index series. For example, an index introduced in January should have a price reference of either the month prior, December, or an average of the previous year.

9.28 For infrequently updated CPIs, a single year is preferred as the price reference period. If a single month (or quarter) is used, the prices of some seasonal products will be unavailable or unusually high or low and a large number of unusual or imputed prices may have to be used for the price reference period. Furthermore, if a single unusual price reference month is to act as the reference period, the initial result of the index change may be a distorted one. Preferably the price reference period for infrequently updated CPIs is a whole year in which seasonal prices would be appropriately represented. In some months there will be no sales, for example, of a seasonal fruit, but an average price for the whole year would still be available for the price reference period. For a homogeneous item specification, say a large Bartlett class I pear grown in California, it is recommended that, data permitting, the average price used in the reference period be a unit value, that is, the sum of the value purchased over the whole year divided by the sum of the quantity purchased as measured in the HBS. The advantage of the unit value is that the resulting average price gives accordingly less weight to prices in months in which there were fewer purchases.

9.29 If the NSO chooses the annual period for the price reference period, it will need annual average prices for all items of the rebased series. Such prices will be collected alongside those of the existing index and in many cases may be for the same specification. The existing index's prices, for example for 2017, will be collected and used for the monthly index compiled and published for 2017, however the prices for the supplementary items/products for the new index should be collected alongside them for the rebased index to commence in January 2018, or soon afterwards, with year 2017 as the index reference period (100). The price collection for the items that belong to the old index but not to the new index can be stopped once the rebased index has been released.

9.30 It is important to stress the practical arrangements required for price collecting the specifications for the new index alongside the old. Many items sold in the same outlets sampled for the existing index will remain the same for the revised index and thus involve no additional workload. There may be some changes to items that replace an old one, for example brown sauce, with a new one, say ketchup, in the same outlet which again requires limited additional resources. However, the very need for the rebase to capture changes in item/variety specifications

and include new outlets in place of old ones—a purpose of the rebasing—will require prices to be collected for some new items in new outlets. Resources have to be committed in advance to plan for this. The sampling of products and broad item specifications and the associated outlet selection provides the basis for determining the new item/variety specifications to be sampled and the old ones replaced.

9.31 Some of the items for the new index will be the same as the old; some will be different, but available in the same outlet; and some will be available in new outlets, with the existing or new items. These provide the prices in the price reference period from which the new index is measured. An average of the existing index for 2017 and the rebased index 2017 = 100 provides the linking factors that enable the new index to be a continuation of the existing index.

9.32 It is usually the case that the overlap year and prices collected for the rebased index are for a period following the weight reference (survey) period. This is because CPI compilers have to wait until the results of the HBS have been compiled and new elementary aggregates determined to know what to price. The purpose of rebasing is to update the products and items priced and this needs to be informed by results from the survey. For example, the HBS may be undertaken in 2015; during 2016 (i) the results would be compiled to yield expenditure shares by product category (and possibly region); (ii) the results are validated/developed using ancillary data as appropriate; (iii) elementary aggregate products are selected (e.g., using cut-off sampling) and their broad specifications developed; (iv) use of centrally-determined prices for selected products are determined (e.g., electricity, water, insurance); and (v) an outlet sample selected for the remaining products. Pricing will commence with an initiation of the sample by visits to the outlets to determine and price the appropriate representative attributes for the selected item. This may commence in January 2017 or later depending on the resources of the NSO. A whole year's price data, say for 2017, will be collected for the new products and their specifications alongside the old. The rebased index will be a Lowe index with a weight reference period of 2015 and a price and index reference period of 2017 = 100.

9.33 NSOs that calculates the elementary indices as chained monthly indices in which prices are compared to previous month's prices, have the advantage of being able to readily introduce replacement items/varieties so the task of collecting specifications for the new index alongside those of the existing one will be less arduous. The long-term price relative method (i.e., the current period price compared to the average price from the price reference period), makes such procedures more difficult because adjustments to base prices are often required.

Monthly (Or Quarterly) Reference Period

9.34 NSOs that use chained CPIs and annually update their weights with a relatively small-time lag between the weight and price reference period should use a single month as the price reference period. For instance, the weights that refer to year y-2 are available and finalized in year y-1 so that they can be introduced in the January index of year y with December year y-1 as the price reference period. There is a continuing flow of price data that may include imputations, and a relatively small number of changes in specifications or products; the major exercise is to bring the new weights to bear on the flow of price data and link this to the existing chain. At the same time, the annual update of the price reference period remains an opportunity for re-sampling in order to ensure that the basket remains representative, and for possibly implementing other methodological improvements.

9.35 For infrequently updated CPIs (i.e., those updated every five years or less frequently), the use of a single-month price reference period is not ideal; however it is often the case that the resources of an NSO are only sufficient to allow for a price reference period of less than a year. Often this is monthly, though it follows from the reasons given in paragraphs 9.28 and 9.29 that six-months is preferred to quarterly, and quarterly to monthly. The principles for using a monthly price reference period are similar to those of an annual one, the issue being to mitigate as much as possible its shortcomings.

9.36 A primary shortcoming of using a monthly reference period is that out-of-season items in the price reference period will have no observed or economically meaningful price. The decision as to which month to use for the price reference month should take account when seasonal items with relatively high weights are in-season. If not in season, an imputed price will have to be used and consideration should be given to the validity of imputation methods for out-of-season items in this context. For example, if the carryfor method is used, the month's imputed price in the price reference period for the out-of-season item may be unduly low. As mentioned above, the short-term price relative method is preferred since it avoids a need for long-run price comparisons with this one-month price reference period.

Developing Update Factors

9.37 While an NSO can maintain the same weights and price reference period, most NSOs choose to use a more current period to introduce the new weight structure. Assume the NSO decides to introduce the new weights from the 2015 HBS in the January 2018 CPI with a price reference date of December 2017, it has two choices for the weights: (a) introduce the 2015 weights directly, or (b) price update the weights to December 2017. As noted, the first choice will result in a Young index while the second will result in a Lowe index.

9.38 Table 9.2 presents the approach for price updating the weights from the 2015 weight reference period to December 2017. A single month is used here for illustrative purposes although, for reasons outlined in paragraphs 9.28 and 9.29, the whole year 2017 could also be used. The NSO begins the rebased CPI using the price data for December 2017 and January 2018. It also produces the old CPI with 2010=100 for December 2017. These data will be used for linking the old and new series as discussed in paragraphs 9.73 to 9.88.

9.39 The first step in updating the weights is to develop the update factors that measure the price change from 2015 to December 2017. This process requires a measure of price

Table 9.2. Updating Weights for Price Change from Weight Reference Period

COICOP Code	Description	Expenditure Share 2015	Avg. CPI 2015	CPI Dec. 2017	Update Factor	Updated Weight	Normalized Weight
(A)	(B)	(C)	(D)	(E)	(F) Col E/D	(G) Col. FxC	(H)
01	**Food and Non-alcoholic Beverages**	**100.000**				**206.883**	**100.000**
01.1	**FOOD**	**93.306**				**197.80**	**95.61**
01.1.1	**Bread & Cereals**	**21.419**				**40.08**	**19.37**
01.1.101	Rice (white)	1.406	150.7	318.1	2.111	2.969	1.435
01.1.102	Rice (Brown)	3.361	151.7	224.6	1.480	4.975	2.405
01.1.103	Flour	2.578	134.8	320.2	2.375	6.121	2.959
01.1.104	Bread	6.864	127.2	222.4	1.748	12.006	5.803
01.1.105	Biscuits (Salted)	0.813	113.0	140.1	1.240	1.008	0.487
01.1.106	Cakes, Pastry, etc.	1.034	131.2	233.7	1.781	1.842	0.891
01.1.107	Chow mein	1.716	125.1	309.8	2.476	4.247	2.053
01.1.109	Macaroni	1.284	105.8	200.3	1.893	2.429	1.174
01.1.110	Oat flakes	0.450	100.6	225.7	2.244	1.010	0.488
01.1.111	Sago	0.341	103.5	222.9	2.154	0.735	0.355
01.1.112	Tennis Rolls	1.392	126.0	219.6	1.743	2.426	1.173
01.1.113	***Whole Wheat Bread****	0.180	***127.2***	***222.4***	1.749	0.315	0.152
01.1.2	**Meat**	**17.632**				**39.94**	**19.31**
01.1.201	Stew Beef	1.940	110.5	254.8	2.306	4.474	2.162
01.1.205	Chicken (live)	1.038	112.6	229.7	2.040	2.117	1.023
01.1.206	Chicken (frozen)	10.202	110.2	252.5	2.291	23.370	11.296
01.1.207	Pork Leg	0.610	138.8	483.4	3.483	2.123	1.026
01.1.210	***Corned beef****	0.866	***111.9***	***253.7***	2.114	1.832	0.949
01.1.211	Duck	0.217	107.3	148.3	1.382	0.300	0.145
01.1.212	Liver	0.207	115.4	198.6	1.720	0.356	0.172
01.1.213	Mutton	0.271	106.8	256.7	2.404	0.651	0.315
01.1.214	Sausages (pork & chicken)	1.823	120.3	233.0	1.937	3.531	1.707
01.1.215	***Brisket****	0.458	***110.5***	***254.8***	2.306	1.056	0.511
01.1.3	**Fish & Seafood**	**5.982**				**12.66**	**6.12**
…	…	…	…	…	…	…	…

change for the elementary aggregates in the new basket. A large majority of the items in the new basket are the same as in the previous basket and continue in the rebased CPI. Their price change can be measured either by using a matched sample of (geometric) average prices for 2015 compared to those in December 2017 or elementary aggregate price indices over the same period. It is very difficult to have the same set of matched price observations in both periods because product substitutions have most likely occurred over the two-year period. Therefore, NSOs will find it easier to use the elementary aggregate indices already available for the CPI elementary aggregates that continue.

$$Factor_i^{Dec\ 2017} = I_{i,\,2010=100}^{Dec\ 2017} / I_{i,\,2010=100}^{Avg\ 2015} \qquad (9.3)$$

9.40 There is an issue, however, for deriving the update factors for the new elementary aggregates in the basket. As previously noted, NSOs will not have price data for the new items from 2015, nor will they have price indices to use for calculating the weight update factors for the new elementary aggregates.[3] In some instances the CPI compiler may have anticipated that certain items were becoming important and most likely would appear in the new basket. For these items, the compiler may have collected prices or started test elementary aggregate indices during 2015. Such cases are the exception rather than the rule, and it is unlikely that all new items in the basket will have prices or indices available in December 2017.

9.41 For the new items, the CPI compiler can identify existing elementary aggregates whose price trends might be reflective of the new elementary aggregates in the basket. Otherwise, the price index for the higher-level class aggregate can be used. In Table 9.2, there are three new items and for each of these the CPI compiler needs to select a representative elementary aggregate price index. As in the previous example, brisket uses the stew beef index as representing its trend. For most other new items, the same approach is taken: whole wheat bread uses the bread index. The only item for which the class index is used is corned beef.

9.42 For each elementary aggregate index in Table 9.2, the 2015 monthly indices were averaged for the calendar year and appear in column D.[4] The December 2017 indices are in column E. The update factors are calculated in column F as the December 2017 index (column E) divided by the 2015 average index (column D). Next, the 2015 weights (column C) are multiplied by the update factors (column F) to derive the updated weights (column G). Finally, the updated weights are normalized (divided by the total of the

[3] A similar issue may arise with changes to the classification system or introduction of new geographical areas into the CPI.

[4] The calculations for updating the weights are only made for the item indices where the new weights are applied. The class and higher-level indices will be calculated using the weights updated to December 2017 in paragraphs 9.47–9.56.

updated weights in the first row of column G and converted to percentages) to sum to 100 (column H).

$$\textit{Updated weight: } w_i^{2015(Dec\ 2017)} = Factor_i^{Dec\ 2017} w_i^{Avg\ 2015}$$

$$\textit{Aggregate updated weight: } w_{agg}^{2015(Dec\ 2017)} = \sum_{i=1}^{k} w_i^{2015(Dec\ 2017)}$$

$$\textit{Percentage shares: } s_i^{Dec\ 2017} = \left(w_i^{2015(Dec\ 2017)} \Big/ \sum_{i=1}^{n} w_i^{2015(Dec\ 2017)} \right) \times 100$$

9.43 Note that the update factors are only calculated at the elementary aggregate level and are used only to update the elementary aggregate weights. The higher-level weights are calculated by aggregating the lower-level weights: (i) subclass weights are the sum of the elementary aggregate weights within the subclass, (ii) class weights are the sum of the subclasses within the class, (iii) group weights are the sum of the classes within the group, and (iv) the division weights are the sum of the groups within the division. If the NSO calculates an update factor at the subclass level, it will not get the same result as when summing the elementary aggregate weights. The new aggregated weights reflect the new basket's structure. Using the aggregate indices to calculate update factors at the subclass level or above reflects the structure of the old basket.

9.44 Another important point is that, when price updating the weights, the elementary aggregates that have relatively larger price changes from the weight reference period receive a larger share of the weight and those with relatively lower price changes receive a smaller share. For example, the elementary aggregate with the largest price change is pork leg (update factor of 3.484) and the updated weight is 1.026 versus 0.610 in the weight reference period. The elementary aggregate with the smallest price change is biscuits (update factor of 1.240) and the updated weight is 0.813 verses 0.487 in the weight reference period. In sum, all the elementary aggregates that exceed the average price changes receive greater weight than in the weight reference period while all the elementary aggregates with less than average price changes receive less weight.

Introducing New Weights

9.45 The NSO has three options on introducing the new basket and weights. First, new weights can start with the weight reference period and price reference period being the same (Laspeyres). The second option is to introduce the expenditure weights directly in a new (subsequent) price reference period (Young). The third option is to introduce price-updated weights in a new price reference period (Lowe). Each of these options is demonstrated in paragraphs 9.46 to 9.54.

Introduce New Weights With the Same Weight and Price Reference Periods—Laspeyres Index

9.46 The NSO can use the weight reference period as the price reference period. In addition, the NSO would also need to reset the index reference period of the elementary indices to 100 using the same period as the weight and price reference periods. In Table 9.3 the average price for 2015 (the weight reference period for the HBS) is set to 100 (column D) by dividing all the elementary indices by their 2015 average and expressing them as an index. In columns E, F, and G, the new weights are used to aggregate the rebased elementary indices to higher levels starting with the subclass levels.

$$I_i^{t,2015=100} = I_i^{t,2010=100} / I_i^{2015\ Avg,\ 2010=100} \tag{9.4}$$

At the elementary aggregate level the new weights are applied to derive all higher-level indices, up to the overall CPI.

$$I_{agg}^{t,2015=100} = \sum_{i=1}^{k} w_i^{Avg\ 2015} I_i^{t,2015=100} / \sum_{i=1}^{k} w_i^{Avg\ 2015} \tag{9.5}$$

9.47 The CPI compiler must complete this aggregation for all months from January 2015 through January 2018. Table 9.3 only shows the aggregates for three months—December 2016, December 2017, and January 2018. The revised index series will now be available from 2015 through January 2018.

9.48 The argument for keeping the weight reference period and price reference period the same is that the resulting price index will approximate a true Laspeyres index; however, this procedure is not without problems. Consider for example a weight reference period of 2015 for which the new sample of products/items have prices collected in 2017 with an aim to commence the index in January 2019. Instead of using 2017 as the new overlap index reference period, 2015 = 100 is used. As explained below, this is achieved by backcasting the 2017 prices to 2015, a procedure that may involve some imputations. Nonetheless, if this method is used, what is derived is a Laspeyres index with the same weight and price reference periods. However, the interest in compiling the new rebased index is for indices from January 2016 onward. The period-to-period comparisons use Laspeyres price indices, but the resulting measure will be a Lowe index comparison, not Laspeyres. The ratio of the two Laspeyres indices used in calculating the price change results in a Lowe formula as follows:

$$I_L^{0:t} / I_L^{0:t-1} = \frac{\sum p_i^t q_i^0}{\sum p_i^0 q_i^0} \Big/ \frac{\sum p_i^{t-1} q_i^0}{\sum p_i^0 q_i^0} = \frac{\sum p_i^t q_i^0}{\sum p_i^{t-1} q_i^0} \tag{9.6}$$

where $I_L^{0:t}$ is the Laspeyres price index for period t

$I_L^{0:t-1}$ is the Laspeyres price index for period $t-1$

9.49 The resulting price change does not yield a Laspeyres price index but a Lowe index where the quantities of period 0 are valued at the prices in period t and t–1. A true Laspeyres index would value the fixed quantities of period t-1 at the prices of period t-1 and t (i.e., $\sum p_i^t q_i^{t-1} / \sum p_i^{t-1} q_i^{t-1}$). Thus, going through the process of calculating the Laspeyres index by backcasting still results in comparisons that result in Lowe index price changes.

9.50 The NSO often has difficulty in obtaining price measures for new items that are introduced with the new weights. Because of the time lag between the HBS and the development of the CPI weights, the required price data to use as the reference prices would usually be two to three years old. Retail outlets will find it very difficult to provide accurate prices for the period covered by the weights. This

Table 9.3. Updated CPI with the Same Weight and Price Reference Periods

COICOP Code	Description	Expenditure Share 2015	Avg. CPI 2015	CPI Dec. 2016	CPI Dec. 2017	CPI Jan. 2018
(A)	(B)	(C)	(D)	(E)	(F)	(G)
01	**Food and Non-alcoholic Beverages**	**100.00**	**100.00**	**153.20**	**206.41**	**209.24**
01.1	**FOOD**	**93.31**	**100.0**	**155.7**	**211.5**	**214.4**
01.1.1	**Bread & Cereals**	**21.42**	**100.0**	**143.6**	**187.1**	**189.5**
01.1.101	Rice (white)	1.406	100.0	155.5	211.1	213.2
01.1.102	Rice (Brown)	3.361	100.0	124.0	148.0	150.2
01.1.103	Flour	2.578	100.0	168.7	237.5	242.2
01.1.104	Bread	6.864	100.0	137.5	174.9	176.7
01.1.105	Biscuits (Salted)	0.813	100.0	112.0	123.9	125.8
01.1.106	Cakes, Pastry, etc.	1.034	100.0	139.1	178.1	181.7
01.1.107	Chow Mein	1.716	100.0	173.8	247.6	250.1
01.1.109	Macaroni	1.284	100.0	144.6	189.3	190.2
01.1.110	Oat flakes	0.450	100.0	162.2	224.4	227.8
01.1.111	Sago	0.341	100.0	157.7	215.5	218.7
01.1.112	Tennis Rolls	1.392	100.0	137.2	174.3	176.0
01.1.113	***Whole Wheat Bread****	0.180	***100.0***	***137.5***	***174.9***	***178.4***
01.1.2	**Meat**	**17.63**	**100.0**	**161.6**	**226.5**	**226.9**
01.1.201	Stew Beef	1.940	100.0	165.3	230.6	232.9
01.1.205	Chicken (live)	1.038	100.0	152.0	204.0	207.0
01.1.206	Chicken (frozen)	10.202	100.0	164.5	229.1	233.6
01.1.207	Pork Leg	0.610	100.0	224.2	348.3	351.8
01.1.210	***Corned beef****	0.866	100.0	128.5	226.8	159.3
01.1.211	Duck	0.217	100.0	119.1	138.2	141.0
01.1.212	Liver	0.207	100.0	136.0	172.0	173.8
01.1.213	Mutton	0.271	100.0	170.2	240.4	241.6
01.1.214	Sausages (pork & chicken)	1.823	100.0	146.8	193.7	196.6
01.1.215	***Brisket****	0.458	***100.0***	***165.3***	***230.6***	***234.0***
01.1.3	**Fish & Seafood**	**5.98**	**100.0**	**155.8**	**211.6**	**214.5**
…	…	…	…	…	…	…

can be problematic for an index that uses the long-term price relative method (i.e., the current period price compared to the average price from the price reference period).

9.51 The alternative is to use price indices to measure the change in prices for the time lapse between the weight reference period and the introduction of the new weights. For items that are already in the CPI basket, their index can be re-referenced to the weight reference period. For example, if the current time period is late in 2017 and the weight reference period is 2015, the NSO can use the annual average price index for 2015 to re-reference the series so that the 2015 average is set to 100. Or it could use the prices for the item from 2015 (if they are available) to calculate the 2015 average price and compare current period prices to the 2015 average.

9.52 For new items to the CPI, the NSO will not have the prices or an index for the item. In this case, an index for a related item or for the subclass in which the new item is included may be used to reflect the price change from the weight reference period.

Introduce the New Weights Directly in a New Price Reference Period—Young Index

9.53 The second option is for the NSO to introduce the new weights directly in a new price reference period. As discussed in paragraphs 9.12 to 9.18, this may be the preferred approach if there has been significant price change between the weight reference period and the introduction of the new weights.

9.54 Assume the CPI compiler has decided to introduce the new weights directly in December 2017 to use in the compilation of the January 2018 index (skipping the compilations in columns D to F of Table 9.3). The new price reference period is December 2017. The price relatives for January 2018 are used to estimate the January 2018 elementary index levels and the new weights (from Table 9.4, column C) are used directly with the elementary indices to derive the higher-level aggregates.

9.55 The new index starts with December 2017 = 100 as shown in column D of Table 9.4. The January 2018 elementary indices appear in column E. The 2015 CPI weights are used to aggregate the elementary indices to the subclass, class, group, and division levels as discussed in the previous example.

$$I_i^{t,\,Dec2017=100} = \left(\prod_{j=1}^{m} I_j^t \Big/ I_i^{Dec2017} \right) \times 100 \qquad (9.7)$$

9.56 The aggregate index changes are different from those in the previous example because the weights reflect that the expenditure shares are kept fixed at their 2015 levels, but not used in the index calculation until December 2017.

$$I_{agg}^{t,\,Dec2017=100} = \sum_{i=1}^{k} w_i^{Avg\ 2015} I_i^{t,\,Dec2017=100} \Big/ \sum_{i=1}^{k} w_i^{Avg\ 2015} \qquad (9.8)$$

In Table 9.3, the price change for Food and Non-alcoholic Beverages is 1.37 percent ([209.24 ÷ 206.41] x 100 – 100), compared to 1.36 percent (column E) in Table 9.4.

Introduce the Updated Weights in a New Price Reference Period—Lowe Index

9.57 The third option is for the NSO to introduce the new weights updated for price change between 2015 and December 2017 (Table 9.2, column H) in the new price reference period. The new price reference period is December 2017. The price relatives for January 2018 are used to estimate the January 2018 elementary index levels and the price-updated weights are used with the elementary indices to derive the higher-level aggregates.

9.58 Referring to Table 9.4, the revised index starts with December 2017 = 100 as shown in column D. The price-updated weights from 2015 to December 2017 (column F) are used to aggregate the elementary indices to the subclass, class, group, and division levels as discussed in the previous examples.

$$I_{agg}^{t,\ Dec2017=100} = \sum_{i=1}^{k} w_i^{2015(Dec2017)} I_i^{Dec2017:t} \Big/ \sum_{i=1}^{k} w_i^{2015(Dec2017)} \quad (9.9)$$

The aggregate index changes are the same as those in Table 9.3 because the weights reflect the fact that the quantities (not expenditure) shares are fixed at their 2015 levels. In Table 9.4, the price change for Food and Non-alcoholic Beverages using the price-updated weights is 1.37 percent (column G).

9.59 In the first approach (Table 9.2), the NSO estimated a Laspeyres index with the quantity shares fixed at 2015 levels and the price reference period of 2015. The Laspeyres index requires that the price and weight reference periods are the same. In the third approach (Table 9.4, columns F-G), the NSO compiled a Lowe index using price-updated weights to December 2017 with the same date as the new price reference period. The price changes for these two indices will be the same because they keep the same fixed quantities. As prices change through time, the expenditures and their shares will change providing greater importance to those items with larger than average price changes. This fact can be seen in Table 9.2. The aggregate price relative between 2015 and December 2017 is 2.069 (206.883 ÷ 100). All items with price changes (update factors in column F) greater than this value have larger final weights (column H) when compared to the 2015 weights (column 3). The Young index produced in the second approach (column E of Table 9.4) holds the expenditure shares fixed and allows for substitution of quantities inversely proportional to price changes. For this example, the Young index has a smaller price change between December 2017 and January 2018 than the Lowe index, as confirmed by several empirical studies cited earlier (see paragraphs 9.19 – 9.26). In general, however, it cannot be said *a priori* if either the Young or the Lowe index is higher.

Decide on the Index Reference Period

9.60 The NSO has the choice of setting a new index reference period or keeping the old index reference period. In the previous examples, new reference periods were set. In the first case, the NSO used the HBS weight reference period of the 2015 annual average as the weight, price, and index reference periods (Laspeyres index). In the second example, a new price and index reference period was established for December 2017 with the weight reference period of 2015

Table 9.4. Updated CPI with a New Price Reference Period

COICOP Code	Description	Expenditure Share 2015	CPI Dec. 2017	CPI Jan. 2018	Expenditure Share Dec 2017	CPI Jan. 2018
(A)	(B)	(C)	(D)	(E)	(F)	(G)
01	**Food and Non-alcoholic Beverages**	**100.00**	**100.0**	**101.36**	**100.00**	**101.37**
01.1	**FOOD**	**93.31**	**100.0**	**101.38**	**95.61**	**101.39**
01.1.1	**Bread & Cereals**	**21.42**	**100.0**	**101.26**	**19.37**	**101.27**
01.1.101	Rice (white)	1.406	100.0	101.00	1.435	101.00
01.1.102	Rice (Brown)	3.361	100.0	101.50	2.405	101.50
01.1.103	Flour	2.578	100.0	102.00	2.959	102.00
01.1.104	Bread	6.864	100.0	101.00	5.803	101.00
01.1.105	Biscuits (Salted)	0.813	100.0	101.50	0.487	101.50
01.1.106	Cakes, Pastry, etc.	1.034	100.0	102.00	0.891	102.00
01.1.107	Chow Mein	1.716	100.0	101.00	2.053	101.00
01.1.109	Macaroni	1.284	100.0	100.50	1.174	100.50
01.1.110	Oat flakes	0.450	100.0	101.50	0.488	101.50
01.1.111	Sago	0.341	100.0	101.50	0.355	101.50
01.1.112	Tennis Rolls	1.392	100.0	101.00	1.173	101.00
01.1.113	***Whole Wheat Bread****	0.180	***100.0***	***102.00***	0.152	***102.00***
01.1.2	**Meat**	**17.63**	**100.0**	**100.17**	**19.31**	**100.16**
01.1.201	Stew Beef	1.940	100.0	101.00	2.162	101.00
01.1.205	Chicken (live)	1.038	100.0	101.50	1.023	101.50
01.1.206	Chicken (frozen)	10.202	100.0	102.00	11.296	102.00
01.1.207	Pork Leg	0.610	100.0	101.00	1.026	101.00
01.1.210	***Corned beef****	0.866	100.0	70.20	0.949	70.20
01.1.211	Duck	0.217	100.0	102.00	0.145	102.00
01.1.212	Liver	0.207	100.0	101.00	0.172	101.00
01.1.213	Mutton	0.271	100.0	100.50	0.315	100.50
01.1.214	Sausages (pork & chicken)	1.823	100.0	101.50	1.707	101.50
01.1.215	***Brisket****	0.458	***100.0***	***101.50***	0.511	***101.50***
01.1.3	**Fish & Seafood**	**5.98**	**100.0**	**101.28**	**6.12**	**101.37**
…	…	…	…	…	…	…

(Lowe index or Young index). The previous index reference period was 2010 and the NSO also has the option to maintain the 2010 index reference period. In such an instance, the weight (2015), price (December 2017), and index (2010) reference periods might all be different.

9.61 Many NSOs change the index reference period to correspond to the price reference period. Often this is the case in countries where CPI revisions have historically occurred on a ten-year cycle or longer. Defining a new index reference period often is notice to users that a new basket and CPI procedures have been put in place. Users may not pay close attention to NSO announcements about the CPI being revised, but when they find the new CPI index level on a different reference period, they take note and inquire about getting historical data or the revised CPI on the old index reference period.

9.62 If the NSO chooses to keep the old index reference period, users may not notice that the CPI has been revised. Most users are concerned with the overall all-items CPI and perhaps some of the major division indices, and do not necessarily use any of the detailed indices at the group or class level. These users may not realize that the CPI has been revised and that some of the detail has changed because new products entering, old products leaving, and, perhaps, an updated classification system or improved methodologies. However, maintaining the old reference period is probably helpful to most users whose only interest is to monitor changes in the overall CPI. Any changes in weights or methodologies should be clearly explained and announced to users well in advance to avoid any confusion. It should be clear to users that a revised index has been disseminated. All relevant metadata should be updated accordingly.

9.63 If the NSO decides to change the index reference period, the old series should be linked to the new series so that users have the appearance of a continuous CPI series. Nonetheless, users should be advised that the new series is not strictly comparable with the old because of the change in basket, weights, and often methodology. If the NSO keeps the old reference period, the new series must be linked to the old series to give users a continuous series. Linking techniques to form a time series for the CPI are presented in paragraphs 9.73 to 9.88.

Formula Used for Estimation

Elementary Aggregate Indices

9.64 The process of updating the weights from the weight reference period until their introduction in the CPI involved using a long-term price relative as the update factor. The period-to-period estimation of the CPI can be accomplished using either a long-term relative approach or a short-term (two-stage or chained) approach. The long-term relative approach is straightforward in that the elementary aggregate index for the period is derived directly as either the ratio of average prices in the current period to the average prices in the price reference period or the average of the long-term price relative for each observation from the price reference period to the current period.

9.65 Chapter 8 of this Manual and Chapter 6 in *Consumer Price Index Theory* strongly urge the NSOs to use geometric averages of prices and price relatives rather than arithmetic averages whenever weights are not available, and identifies several problems with the arithmetic formulas that are avoided when using geometric averages.

Higher-level Indices

9.66 The higher-level price indices are compiled by either aggregating the elementary (item) level price indices or by aggregating the elementary price relatives. For aggregating indices, the NSO uses the item weights from the introduction of the new CPI series. The weights for the Laspeyres and Young indices refer to the weights from the weight reference period, while those for the Lowe index refer to the price reference period. These weights and their elementary (item) indices are used to calculate weighted average price indices for the current period. As noted earlier, the reference period of the weights and the price reference period used in the index formula determine whether the index is Laspeyres, Young, or Lowe.

9.67 As noted above, aggregating price relatives requires a different set of weights each month to derive the higher-level aggregates. The price relatives have a price reference in the previous period. Therefore, the aggregation weights must refer to the previous period. A good rule to remember is that when calculating price movements, the price period in the denominator of the index formula should be the same as the price period implicit in the weights.

9.68 The weight required is one that reflects the price reference period weights that are price-updated to the previous period. These weights may be referred to as cost weights and reflect what the cost would be to purchase the same quantity of the item at the current period's prices. This weight is derived each period by using the price relatives for the current period to bring forward the previous cost weight. These weights and their elementary (item) price relatives are used to calculate weighted average aggregate price relatives for the current period. The aggregate price relative is multiplied by the previous period aggregate index to derive the current aggregate index.

9.69 The NSOs could also use geometric estimators to derive higher-level indices. Using a Geometric Young, Geometric Laspeyres, or a Geometric Lowe formula could help reduce the substitution bias inherent in the use of fixed base indices. They also provide for consistency in aggregation when geometric indices are compiled at the elementary level.

Linking the Previous CPI to the New Price Index Reference Period

9.70 When the NSO introduces a new basket and weights, the new series is not completely comparable to the previous series. Nonetheless, users typically want a CPI time series that covers a long period of time and provides historical context. In order to provide such a series, the NSO will need to link or splice the two series together. For example, if the previous series had an index reference period of 2012 and the new series has a reference period of 2017, there is likely to be a large difference in the index levels. The CPI with 2012 = 100 will have registered price

changes over the period from 2012 to the end of December 2017. The new series with 2017 = 100 will show little change comparatively with the new index level close to 100. Thus, it becomes important to have procedures for NSOs to use, in this case, to adjust the old series to reflect the level of the new series. Alternatively, the NSO could use procedures to adjust the new series to the level of the old series. These approaches are presented in paragraphs 9.74 to 9.88.

9.71 The NSO may choose to start the new series using the new price reference period. In Chapter 3 the recommendation is that when a new index is introduced there should be an overlap period for the two indices so that they can be linked together. The overlap period is used to develop adjustment factors that may be applied to the old series to bring it to the same level as the new series.

Price Reference Period is a Single Month (Or Quarter)

9.72 At minimum, a single common period is required as an overlap period between the indices. When updating weights less frequently (e.g., every five years), a single common period is not the ideal method. However, some NSOs update the CPI weights each year so that the time lapse between the weight reference period and the link month is short. The single period link could be used in these instances. The NSO should be aware of possible distortions when introducing methodological changes. If the changes result in a different seasonal pattern of the linking month, this would lead to a permanent shift in the level of the index series. Paragraphs 9.98 to 9.113 provide a detailed discussion on annual weight updates.

9.73 Although not a preferred method, some NSOs update the weights using a single period overlap which is presented here as an example of the linking process. Assume December 2017 is the link period and price reference period when the new weights for 2015 will be introduced. Also, the last weight update occurred in December 2012 when the weights for 2010 were introduced. The new CPI and the old CPI series should be produced for December 2017. If that is the case, the linking of the series is straightforward. In December 2017 each of the new CPI indices has a value of 100. For the previous CPI series, each index will have a value that could be different from the new series. The goal of the linking process is to set the old indices' levels to those of the new index. Since the new indices all have a value of 100 and the NSO wants the old indices to have that same value, the NSO can simply reference the old series to 100 by dividing each item, subclass, class, group, etc. index by its value for December 2017. The NSO can also derive an adjustment factor for each of the new CPI series that users can apply to the new series going forward in time to raise the new series level to that of the old series if the index reference period is to remain the same as that for the old CPI (December 2012 = 100).

9.74 Table 9.5 provides an example of linking the previous and revised CPI using a single period overlap. The table contains the old CPI for a Division (Food and Non-alcoholic Beverages), a Group (Food), two classes (Bread & Cereals and Meat)[5], and 12 items. Column D contains the old CPI

[5]These classes refer to COICOP 1999. In COICOP 2018, these classes have been revised to Cereals and Cereal Products and Meat, Fresh, Chilled, or Frozen.
[6]These classes refer to COICOP 1999. In COICOP 2018, these classes have been revised to Cereals and Cereal Products and Meat, Fresh, Chilled, or Frozen.

Table 9.5. Linking CPI Series Using a Single Period Overlap on a New Index Reference Period[6]

COICOP Code	Description	Expenditure Share 2015	Old CPI for Dec. 2017 Dec. 2012=100	New CPI for Dec. 2017 Dec. 2017=100	Linking Factor Backward (Old Series)	Linking Factor Forward (New Series)
(A)	(B)	(C)	(D)	(E)	(F) Col. E / D	(G) Col. D / E
01	**Food and Non-alcoholic Bev.**	**100.00**	**119.88**	**100.00**	**0.8341**	**1.1988**
01.1	**FOOD**	**94.83**	**119.80**	**100.00**	**0.8347**	**1.1980**
01.1.1	**Bread & Cereals**	**22.41**	**132.49**	**100.00**	**0.7548**	**1.3249**
01.1.101	Rice (white)	5.759	150.7	100.0	0.6636	1.5070
01.1.102	Rice (Brown)	0.381	151.7	100.0	0.6591	1.5173
01.1.103	Flour	4.356	134.8	100.0	0.7416	1.3484
01.1.104	Bread	6.167	127.2	100.0	0.7863	1.2718
01.1.105	Biscuits (Salted)	1.083	113.0	100.0	0.8846	1.1305
01.1.106	Cakes, Pastry, etc.	0.375	131.2	100.0	0.7622	1.3121
01.1.107	Chow Mein	1.370	125.1	100.0	0.7992	1.2513
01.1.109	Macaroni	0.426	105.8	100.0	0.9447	1.0585
01.1.110	Oat flakes	0.751	100.6	100.0	0.9945	1.0056
01.1.111	Sago	0.535	103.5	100.0	0.9664	1.0347
01.1.112	Tennis Rolls	0.589	126.0	100.0	0.7938	1.2598
01.1.113	***Whole Wheat Bread****	0.622	***127.2***	***100.0***	***0.7863***	***1.2718***
01.1.2	**Meat**	**17.358**	**111.87**	**100.00**	**0.8939**	**1.1187**

in the overlap month (December 2017) and column E presents the new index in the overlap month (and new price reference period) so that all series are equal to 100. There are two ways to link the old series to the new series level going backward in time. The first is to re-reference the old series by dividing each old series by the overlap period index (December 2017 value). The second method is to calculate a "linking factor" that can be applied to each of the old series historically. This linking factor is the reciprocal of the December 2017 index level and appears in column F. Multiplying each series by their link factor backward in time has the same effect as dividing by the December 2017 value. These methods are applied to all index series in the old CPI at all levels—Division, Group, Class, Subclass, and Item.

9.75 If the NSO or users want to continue the old series CPI going forward in time, they can produce a set of forward linking factors to use in future months as the new CPI is released. The forward linking factor raises the level of the new CPI series to that of the old series thus keeping the series on the old reference period. The forward linking factors (column G) are simply the ratios of the old index levels (column D) to the price reference index levels (column E).

$$Backward\ Linking\ Factor_i = 1 / Link\ period\ index_i$$

$$Forward\ Linking\ Factor_i = Link\ period\ index_i / 100$$

Price Reference Period is a Yearly Average

9.76 Most NSOs will establish a new price reference period using an annual average from a previous year. The simplest and easiest method is to link the series with data for the month preceding the introduction of the new series (link month). This involves re-referencing the old series at each level to the annual average index for the new price reference period. However, there will be a discontinuity between the index level for the new index and that for the re-referenced index level for the old series in the link month. This reflects the difference in price trends between the old and new series as the new weights are being introduced. Table 9.6 shows the method for linking a new series to the old using a

Table 9.6. Linking Old and New Index Series to a Previous Annual Average[6]

		CPI (2012=100)	Forward Link	CPI (2017=100)	Backward Link	12-month % change	
(A)		(B)	(C)	(D)	(E)	(F)	(G)
Year	Month	All Items	2017=100	All Items	2017=100	old series	new series
2016	Jan	123.2	94.7		94.7		
	Feb	124.7	95.8		95.8		
	Mar	125.1	96.1		96.1		
	Apr	125.6	96.5		96.5		
	May	125.8	96.7		96.7		
	Jun	126.5	97.2		97.2		
	Jul	126.5	97.2		97.2		
	Aug	126.7	97.4		97.4		
	Sep	126.8	97.4		97.4		
	Oct	127.3	97.8		97.8		
	Nov	127.8	98.2		98.2		
	Dec	127.6	98.1		98.1		
	AVG	**126.1**	**96.9**		**96.9**		
2017	Jan	128.1	98.4	98.5		4.0	4.0
	Feb	128.1	98.4	98.5		2.7	2.8
	Mar	128.4	98.7	98.8		2.6	2.8
	Apr	129.4	99.4	99.6		3.0	3.2
	May	129.6	99.6	99.8		3.0	3.2
	Jun	130.2	100.1	100.1		2.9	3.0
	Jul	130.6	100.4	100.3		3.2	3.2
	Aug	131.5	101.1	100.7		3.8	3.4
	Sep	131.5	101.1	100.9		3.7	3.6
	Oct	131.4	101.0	101.1		3.2	3.4
	Nov	131.4	101.0	100.9		2.8	2.7
	Dec	131.4	101.0	100.8		3.0	2.8
	AVG	**130.133**	**100.000**	**100.000**		**3.2**	**3.2**
Link	**Factors**		**1.00172**	**0.768443**			
2018	Jan		101.9	101.7		3.5	3.2
	Feb		102.1	101.9		3.7	3.5
	Mar		101.9	101.7		3.3	2.9
	Apr		102.2	102.0		2.8	2.4
	May		102.2	102.0		2.6	2.2
	Jun		102.8	102.6		2.7	2.5
	Jul		103.0	102.8		2.6	2.5
	Aug		103.0	102.8		1.9	2.1
	Sep		103.4	103.2		2.3	2.3
	Oct		103.6	103.4		2.6	2.3
	Nov		103.7	103.5		2.7	2.6
	Dec		104.7	104.5		3.7	3.7

previous year's annual average index as the new index reference period. There are three steps involved: (i) re-reference the old index series to the new index reference period; (ii) compile the new index series in the link month using the new weight structure; and (iii) link the new series to the old series by using forward linking factors or, if using the short-term price relative method, start the new series indices at the level of the old series in the link month.

Step 1: Calculate the annual average index from the old series for the new index reference period which in this example is 2017. The annual average index for 2017 with 2012 = 100 appears in column B. The new index starts in January 2018 with 2017 = 100 and the link month is December 2017. The old series is then re-referenced to the new reference period by dividing the monthly indices by the 2017 annual average which appears in column B. The link month index for the old series is December 2017.

$$I^{t,\ 2017=100}_{w=2012} = I^{t,\ 2012=100}_{w=2012} \Big/ I^{Avg\ 2017,\ 2012=100}_{w=2012} \tag{9.10}$$

The re-referencing of the old series could also be done by using a backward linking factor that is the reciprocal of the new reference period average for the old index (column B: 1/1.30133 = 0.768443). The backward linking factor is in column D and the backward linked series is in column E (note that column E is identical to the series in column C). Whereas the forward linking factor is based on a single month (monthly overlap), the backward linking factor is based on an entire year (annual overlap).

Step 2: The indices for the new series are compiled for all months of 2017 using the new weights and price reference period. These appear in column D of Table 9.6.

$$I^{Jan\ 2017,\ 2017=100}_{w=2017} = \left(\sum_{i=1}^{n} w_i^{2017}\left(I_i^{Jan\ 2017} / I_i^{Avg\ 2017}\right)\right) \times 100 \tag{9.11}$$

$$I^{Dec\ 2017,\ 2017=100}_{w=2017} = \left(\sum_{i=1}^{n} w_i^{2017}\left(I_i^{Dec\ 2017} / I_i^{Avg\ 2017}\right)\right) \times 100 \tag{9.12}$$

Step 3: Because there is a difference in the index levels for the two series in the December 2017 link month, the new series should be linked to the re-referenced old series index level in the link month. This approach maintains a continuous series that will reflect the short-term price movements of the old series up to the link month and the short-term price movements for the new series following the link month. The easier approach is to simply use the link month level of the re-referenced old series as the starting point for the new series.

$$I^{Jan\ 2018,\ 2017=100}_{w=2017} = I^{Dec\ 2017,\ 2017=100}_{w=2012} \times \left(\sum_{i=1}^{n} w_i^{2017,Dec17}\left(I_i^{Jan\ 2018} / I_i^{Dec\ 2017}\right)\right) \tag{9.13}$$

Where: $w_i^{2017,Dec2017} = w_i^{2017}\left(I_i^{Dec2017} \Big/ I_i^{Avg\ 2017}\right) \Big/ I^{Dec2017,2017=100}_{w=2017}$

From the example, all the indices for December 2017 in the new series will be set to the index levels of the re-referenced old series in column C. This method is consistent with using the short-term price relative compilation procedure. The other approach is to calculate a forward linking factor to apply to each of the new index series every month in the future.

$$I^{Jan\ 2018,\ 2017=100}_{w=2017} = Linking\ factor_i \times \left(\sum_{i=1}^{n} w_i^{2017}\left(I_i^{Jan\ 2018} / I_i^{Dec\ 2017}\right)\right) \tag{9.14}$$

$$Linking\ factor_i = I^{Dec\ 2017,\ 2017=100}_{w=2012} / I^{Dec\ 2017,\ 2017=100}_{w=2017}$$

The forward linking factor is calculated by dividing the link month index level of the old series (December 2017) by the link month index level of the new series: (131.4/130.133) × 100/100.8 = 1.00172. In the example, the old series link month index is in column C and the new series link month index is in column D. The forward linking factor appears in column C.

9.77 An important point to note when new series are introduced is the calculation of the 12-month (year-over-year) inflation rates. Series with annual overlaps provide two sets of indices to use for the annual inflation rates. The old series will have inflation rates calculated through the link month. In Table 9.6, column F shows the inflation rates that would have been calculated using the old series (note that the inflation rates are the same for the original and rebased series). In the example, the NSO has not published the new series; it has only published the old series on the 2012 = 100 base. The inflation rates during 2018 should then be calculated using the rebased series (2017 = 100 in column D), as appears in column G.

Keeping the Old Index Reference Period

9.78 An alternative method NSOs may pursue is linking the new CPI series to the old CPI series. This approach is similar to linking the new series forward in time to maintain the same index reference period as the old series. The only difference is that the new index on an updated price reference and weight reference period is not released to the public. Instead, linking factors are applied to each index before release. For example, if the NSO kept the index reference period as 2012 = 100 while starting compilation of the new index with 2017 = 100, the forward linking factor in column B of Table 9.7 would be applied to the new index level in column D beginning in January 2018 and continue to be used until the next revision. The forward linking factor is simply the old index series in the new indices' reference period (2017 = 100) expressed as a price relative (column B).

$$I^{Jan\ 2017:t,\ 2012=100}_{w=2017} = Linking\ factor_i \times \left(I^{Jan\ 2017:t,\ 2017=100}_{w=2017}\right) \tag{9.15}$$

$$Linking\ factor_i = I^{Avg\ 2017,\ 2012=100}_{w=2012} / 100$$

9.79 Each period, the new index series is being tied to the old index levels for item and higher-level aggregates. Because the new index series on a new index reference period is not published, the annual rates of change in column F are all calculated using the published series with 2012=100. If the short-term relative compilation method is used, each index starts with its level in December 2017.

Table 9.7. Linking New Series to an Old Index Reference Period

		CPI (2012=100)	Forward Link	CPI (2017=100)	Backward Link	12-month % change
(A)		(B)	(C)	(D)	(E)	(F)
Year	Month	All Items	2012=100	All Items	2017=100	2012=100
2016	Jan	123.2			94.7	
	Feb	124.7			95.8	
	Mar	125.1			96.1	
	Apr	125.6			96.5	
	May	125.8			96.7	
	Jun	126.5			97.2	
	Jul	126.5			97.2	
	Aug	126.7			97.4	
	Sep	126.8			97.4	
	Oct	127.3			97.8	
	Nov	127.8			98.2	
	Dec	127.6			98.1	
	AVG	**126.1**			**96.9**	
2017	Jan	128.1	128.2	98.5		4.0
	Feb	128.1	128.2	98.5		2.7
	Mar	128.4	128.6	98.8		2.6
	Apr	129.4	129.6	99.6		3.0
	May	129.6	129.9	99.8		3.0
	Jun	130.2	130.3	100.1		2.9
	Jul	130.6	130.5	100.3		3.2
	Aug	131.5	131.0	100.7		3.8
	Sep	131.5	131.3	100.9		3.7
	Oct	131.4	131.6	101.1		3.2
	Nov	131.4	131.3	100.9		2.8
	Dec	131.4	131.2	100.8		3.0
	AVG	**130.133**	**130.133**	**100.000**		**3.2**
Link	**Factors**	**1.301333**		**0.768443**		
2018	Jan		132.4	101.7		3.3
	Feb		132.6	101.9		3.5
	Mar		132.4	101.7		3.1
	Apr		132.8	102.0		2.6
	May		132.8	102.0		2.4
	Jun		133.5	102.6		2.6
	Jul		133.8	102.8		2.5
	Aug		133.8	102.8		1.8
	Sep		134.3	103.2		2.1
	Oct		134.6	103.4		2.4
	Nov		134.7	103.5		2.5
	Dec		136.0	104.5		3.5

Example of Calculating New Series at the First Level of Aggregation

9.80 As another example, assume the NSO keeps the 2012 = 100 reference period while introducing the new CPI with 2017 = 100, but the revision starts at the lowest level of aggregation. In this case, the NSO will have to revise elementary price indices with the first pricing period in 2017. Assuming the CPI series is monthly, each monthly elementary aggregate index (first level of aggregation) in 2017 must be divided by the 2017 annual average to re-reference the indices to 2017 = 100. The re-referenced item indices (elementary aggregates) are aggregated using the new weights to derive the higher-level indices.

$$I_i^{m,\,2017=100} = I_i^{m,\,2017} \,/\, I_i^{Avg\ 2017} \tag{9.16}$$

$$I_{w=2017}^{m,\,2017=100} = \sum_{i=1}^{m}\left(w_i^{2017} I_{i,}^{m,\,2017=100}\right) / \sum_{i=1}^{m} w_i^{2017} \tag{9.17}$$

9.81 This aggregation results in a class index that is different from the one obtained by simply re-referencing the old CPI class index. In addition, the new CPI monthly class indices adjusted to the 2012 index reference period will be different because the new weights have changed the levels of the monthly indices.

9.82 The example in the first box of Table 9.8 shows the monthly item and subclass indices for Oils and Fats (COICOP 2018 01.1.5) in 2017 on the old reference period (2012 = 100). It also has the annual averages[7] for 2017 and

[7]Standard international practice for calculating annual average indices is to use a simple arithmetic average of the monthly indices. While geometric averaging could be used, the results can be different when aggregate indices are calculated using arithmetic aggregation. If geometric aggregation were used at the higher level, then geometric annual averages should be used. Consistency in aggregation is important for calculating the annual averages.

the re-referenced monthly indices for the class index in column G (i.e., dividing the monthly class indices by the annual average of 111.8).

9.83 In the second box of Table 9.8 the monthly item indices for the four items in the class are re-referenced to 2017 = 100 and these indices are aggregated (columns B-E) to the class level (column F) using the new weights for 2017. Note that the new class indices with 2017 = 100 in column F of the second box are different from those in column G7 of the first box. The reason for this is that the higher-level indices are compiled using different weights and index levels than those in the old CPI.

9.84 The class indices in column G of the second box represent the new CPI on the weight and price reference for 2017. If the NSO was introducing the new series, then the indices beginning in January 2018 would be linked to the December 2017 index level in column G as shown in Table 9.6. The NSO, however, is keeping the old 2012 index reference period. So it will need to use the forward linking factors to adjust the new CPI levels to the same level as the old CPI. As noted previously in the discussion of Table 9.7, the forward linking factor is the old index level in the overlap period (2017 average) expressed as a price relative (i.e., divided by 100) which is 1.118 (111.8 ÷ 100). This factor is applied to the monthly class level indices in column G of the second box to tie them to the old index levels that appear in column H. Note that these values are different from the values in column G of the first box, again because the new indices are compiled using different weights and index levels than those in the old CPI.

Aggregation Across Linked Series

9.85 When the new series is introduced there is a break in the comparability of the historical indices. The new and previous series are no longer strictly comparable because of the change in weights, item structures, and, in the case of re-referencing the indices, the level of the indices. Each old series is re-referenced to the new index reference period. The re-referenced series will no longer yield the same results as before the rebasing when aggregated. This is demonstrated in column H of Table 9.8. In the first box of column H the new CPI series for the item indices are aggregated using the old item weights. There are differences between the rebased old series (column G) and the re-aggregated new series using old weights (column H) in April, May, September, and December demonstrating the effects of the weight differences. In the second box of Table 9.8, column H, the old item indices are aggregated using the new weights. There are differences in every month reflecting the effects of both the weight changes and the index level differences. Had there been a new item added to the class, for example lard, this could also account for a difference.

Table 9.8 Aggregating new CPI Series using an Annual Period Overlap

2017	Butter, fresh (item)	Margarine (item)	Peanut butter (item)	Vegetable Oil (item) 2012=100	Old CPI Oils & Fats (class)	Old CPI Class index rebase to 2017=100	Old CPI aggregate item indices using rebased series
(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)
Item weights (2012)	0.307	2.669	1.155	2.600	**6.731**		
January	108.2	105.8	108.3	119.4	**111.6**	**99.8**	**99.8**
February	110.5	101.5	98.0	114.5	**106.3**	**95.1**	**95.1**
March	112.8	103.6	100.1	116.9	**108.6**	**97.1**	**97.1**
April	107.1	105.8	97.0	119.4	**109.6**	**98.0**	**97.9**
May	113.9	100.4	103.2	113.3	**106.5**	**95.2**	**95.3**
June	115.1	106.8	104.2	120.6	**112.1**	**100.2**	**100.2**
July	112.8	107.9	102.1	121.8	**112.5**	**100.6**	**100.6**
August	113.9	107.9	102.1	120.6	**112.1**	**100.2**	**100.2**
September	120.8	106.8	103.2	127.8	**114.9**	**102.8**	**102.6**
October	115.1	113.2	109.4	126.6	**117.8**	**105.4**	**105.4**
November	117.4	110.0	104.2	124.2	**114.8**	**102.7**	**102.7**
December	119.6	112.2	106.3	121.8	**115.2**	**103.0**	**103.1**
Average	**113.9**	**106.8**	**103.2**	**120.6**	**111.8**	**100.0**	**100.0**
Re-referenced indices	(2017 =	100)			**New CPI**	**Linked CPI**	**Old base with**
Item weights (2017)	0.269	1.435	1.194	2.674	**5.573**	**2012=100**	**new weights**
January	95.0	99.0	105.0	99.0	**100.1**	**111.9**	**113.0**
February	97.0	95.0	95.0	95.0	**95.1**	**106.3**	**107.4**
March	99.0	97.0	97.0	97.0	**97.1**	**108.6**	**109.7**
April	94.0	99.0	94.0	99.0	**97.7**	**109.2**	**110.5**
May	100.0	94.0	100.0	94.0	**95.6**	**106.9**	**107.9**
June	101.0	100.0	101.0	100.0	**100.3**	**112.1**	**113.3**
July	99.0	101.0	99.0	101.0	**100.5**	**112.4**	**113.6**
August	100.0	101.0	99.0	100.0	**100.0**	**111.9**	**113.0**
September	106.0	100.0	100.0	106.0	**103.2**	**115.4**	**116.8**
October	101.0	106.0	106.0	105.0	**105.3**	**117.7**	**118.9**
November	103.0	103.0	101.0	103.0	**102.6**	**114.7**	**115.9**
December	105.0	105.0	103.0	101.0	**102.7**	**114.8**	**115.9**
Average	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**111.8**	**113.0**

Frequency of Weight Updates

Data Sources for More Frequent Weight Updates

9.86 The primary source for more frequent updating of the CPI would be the HBS; however, in some countries, national accounts data are used as the source for developing new index weights. Countries that have a continuous HBS conducted every quarter or every year can use the data from the HBS to verify any significant shifts in the CPI basket and the weights. The NSO can develop a concordance between the HBS and the CPI basket and review the changes in the basket and weight shares on a regular basis. As the shares shift, the NSO could update the CPI basket as discussed in Chapter 3, paragraph 3.80:

> *Even if weights are updated only every five years, it is desirable to review the weights in between to ensure that they remain sufficiently reliable and representative. The review, which may be limited to weights at the elementary index level and their major components, should examine whether there are indications that important changes may have taken place in the consumption pattern since the weight reference period*.

9.87 There is no specific guidance on what constitutes an important change, but the CPI compiler should look at all changes in shares that exceed ±0.5 percent on an annual basis. Such shifts may indicate significant economic changes in the pattern of consumer purchases.

9.88 If HBSs are conducted on a two- or three-year cycle, the CPI compiler should give serious consideration to updating the weights as the latest HBS results become available. In fact, many countries update their CPI weights every year or every two years to minimize the substitution bias that is problematic with fixed-base indices. Such frequent updating of the weights keeps the CPI basket more representative of consumer purchases.

9.89 As discussed in Chapter 3, other sources for more frequent updating are the national accounts where data on household final consumption expenditure are often available on an annual basis. A retail sales survey could also provide indications of changes in purchasing patterns for goods and services sold at retail outlets.

9.90 The shortcoming of these two data sources is that they do not have the detail that is found in the HBS. Typically, these sources may have data at the COICOP class, group, or even division levels. In such cases, a full reweighting at the item level will not be possible. The NSO will need to decide if it wants to introduce new weights at the higher level, such as the class, group, or division levels, while maintaining the weighting pattern fixed at the lower levels. The introduction of weights for the higher-level aggregates is referred to as "partial reweighting" or "partial weight updates". More generally, this is also an illustration how national accounts and HBS data can be combined in practice in order to derive CPI weights.

9.91 Table 9.9 presents an example of partial weight updates. Assuming that the CPI compiler was able to use data from the national accounts and retail sales survey to derive a new weight distribution at the class level, column D

Table 9.9 Partial Weight Updates at the COICOP Class Level

COICOP Code	Description	Expenditure Share 2015	High-Level Shares 2017	Allocation with 2015 Shares	Updated Shares 2017 base	Allocation with updated 2015 Shares	Updated Shares 2017 base
(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)
01	**Food and Non-alcoholic Bev.**	**100.00**	**100.00**		**100.00**		**100.00**
01.1	**FOOD**	**93.31**	**91.90**		**91.90**		**91.90**
01.1.1	**Bread & Cereals**	**21.42**	**21.90**		**21.90**		**21.90**
01.1.101	Rice (white)	1.406		0.06567	1.438	0.07406	1.622
01.1.102	Rice (Brown)	3.361		0.15692	3.437	0.12411	2.718
01.1.103	Flour	2.578		0.12036	2.636	0.15272	3.345
01.1.104	Bread	6.864		0.32048	7.019	0.29953	6.560
01.1.105	Biscuits (Salted)	0.813		0.03795	0.831	0.02514	0.551
01.1.106	Cakes, Pastry, etc.	1.034		0.04829	1.058	0.04596	1.007
01.1.107	Chow Mein	1.716		0.08009	1.754	0.10596	2.321
01.1.109	Macaroni	1.284		0.05993	1.312	0.06061	1.327
01.1.110	Oat flakes	0.450		0.02101	0.460	0.02519	0.552
01.1.111	Sago	0.341		0.01592	0.349	0.01833	0.401
01.1.112	Tennis Rolls	1.392		0.06498	1.423	0.06053	1.326
01.1.113	***Whole Wheat Bread****	0.180		0.00840	0.184	0.00785	0.172
01.1.2	**Meat**	**17.63**	**16.50**		**16.50**		**16.50**
01.1.201	Stew Beef	1.940		0.11004	1.816	0.11237	1.854
01.1.205	Chicken (live)	1.038		0.05885	0.971	0.05317	0.877
01.1.206	Chicken (frozen)	10.202		0.57862	9.547	0.58705	9.686
01.1.207	Pork Leg	0.610		0.03457	0.570	0.05334	0.880
01.1.210	***Corned beef****	0.866		0.04913	0.811	0.04601	0.759
01.1.211	Duck	0.217		0.01232	0.203	0.00754	0.124
01.1.212	Liver	0.207		0.01174	0.194	0.00894	0.148
01.1.213	Mutton	0.271		0.01536	0.253	0.01636	0.270
01.1.214	Sausages (pork & chicken)	1.823		0.10339	1.706	0.08869	1.463
01.1.215	***Brisket****	0.458		0.02598	0.429	0.02653	0.438
01.1.3	**Fish & Seafood**	**5.98**	**6.70**		**6.70**		**6.70**

contains the compiler derived share weights. The weights at the item level are not available so the compiler chooses to keep the same allocation of the original weights at the item level. This approach assumes the shares will not have changed at the item level and is consistent with a Young index. Column E contains the item allocation share for each class. These are calculated by taking the 2015 expenditure shares for each item (column C) and dividing them by the class share (column C). The item allocation share in column E for each item is multiplied by the new class share to derive the updated item shares in column F. The compiler can use these updated shares in the CPI to revise the weights.

9.92 Another alternative that the NSO could choose for allocating the weights is to use shares derived from the weights updated for price change from the original period when the weights were introduced. This approach assumes the weights have changed because of price change but the quantities have remained the same. It is consistent with a Lowe index. Column G contains the item allocation share for each class using the updated weights.

$$\hat{s}_i^{2017} = S_c^{2017}\left(s_i^{2015}\right) \Big/ \sum_{i=1}^{m} s_i^{2015} \tag{9.18}$$

These are calculated by taking the 2017 cost weights for each item (not shown in Table 9.9) and dividing it by the class cost weight for 2017.

$$S_c^{2017} = w_c^{2017} \Big/ \sum_{c=1}^{k} w_c^{2017} \tag{9.19}$$

9.93 The item allocation share in column G for each item is multiplied by the new class share to derive the updated item shares in column H. The NSO can use these updated shares based on the 2017 cost weights in the CPI to revise the weights.

9.94 The NSO can use either method depending on the type of index they are compiling—Young, Lowe, or Laspeyres. Once the new weights at the item level are available, the NSO can introduce them using the methods described in paragraphs 9.45 to 9.54. The resulting revised indices should be linked to the previous series using the methods described in the previous section on linking the previous CPI to the new index reference period (paragraphs 9.70 – 9.85).

Annual Updating and Linking

9.95 If data are available for updating the weights on an annual basis, the updating procedures for the NSO to use are the same as those already presented. The primary difference is that the process is done every year versus every five to ten years. The NSO must determine when introducing the new weights what the new price reference period will be and the date for the weight update. The weight reference period is still annual (e.g., 2015) so the price reference period could be the annual average for 2017 or December 2017. If this is the case, the NSO will most likely decide not to update the index reference period, and they will use procedures for keeping the same index base (e.g., 2010 = 100) described in paragraphs 9.82 to 9.83.

9.96 If the NSO chooses to update the weights annually with the most recent weight data, it usually does it at the beginning of the year. It also will use the last pricing period of the previous year as the price reference period.[8] The NSO must decide whether to price update the weights to the price reference period or simply introduce them with the new price reference period. In this example, the NSO would need to update the weights from the 2015 annual average to December 2017. The same procedures described for Tables 9.7 and 9.8 apply: (i) re-reference the old series (e.g., with December 2016 = 100) to the new reference (overlap) period (e.g., December 2017); (ii) convert the old index levels in the link month to price relatives by dividing each by 100 to derive the forward linking factors; and (iii) use the linking factor for tying the new series to the old series level going forward in time.

9.97 If this linking process continues for multiple years, the linking factors for each year must be derived from the indices on the fixed index reference period or made cumulative by chaining the annual series through time. With the annual linking, there are a series of one-year links going forward in time. Each annual link starts an index with a new price and index reference period of 100. For the first weight introduction, the annual index starts with 100; for the second, it too will start with 100 as will the third. If the linking factors are calculated at the end of each new annual index, they will only tie the index level to that of the previous annual index. For example, the NSO introduced a new set of weights with a price and index reference period of December 2015 at the end of January 2016. In January 2017, new weights are introduced with December 2016 = 100. In order to keep the previous index reference period of December 2015 = 100, forward linking factors are needed and compiled using the index values for the overlap period in December 2016. These reflect the index level of the previous index period, December 2015. When yet another set of weights are introduced in January 2018 with December 2017 = 100, the linking factors for the overlap period will refer to the index with December 2016 = 100. In this situation, in order to adjust the new index level to that with December 2015 =100, the linking factors for December 2016 and December 2017 must each be used (chained) to get the correct index levels. The series of one-year indices must be chained together because each only represents the change over a yearly period. To get the long-term change, these annual changes need to be made cumulative.[9]

9.98 The aggregation to the higher-levels must always be based on the initial indices using the most recent weights that have not yet been multiplied by the linking factors. The chain-linked indices will not be consistent in aggregation. The published indices may have a reference period of 2015 = 100 but they are initially compiled on a more recent reference period (e.g., December of the previous year). The linking factors are then applied to the new index to adjust to the level of the chain-linked indices. Because there are differences in the index levels, aggregations using the new weights on the chain-linked indices give different results.

[8] The new weights can be introduced in any time period. Normally, the price reference period will either be the date of the weight reference period, a calendar year, or the period prior to the introductory period.

[9] The alternative approach to using linking factors, as discussed earlier, is to apply the short-term price relatives each month to update the previous month's indices.

For users to derive the correct indices for their own special aggregations, they must first unchain the published indices by dividing them with the chain-linked index of the link month before they can be aggregated with the weights that are applied during that year.

9.99 Because of the introduction of new weights every year, the annual rates will not only capture changes in prices but also changes in the weight structure. In such a situation, the contribution of each item to the all-items annual rate of change is ill-defined and different approaches have been proposed for measuring contributions or impacts (paragraphs 9.108 to 9.118 describe how to calculate contributions to change).[10] If the weights are introduced in January with the previous December month having the role of the new price reference period, the distortion on the annual rates caused by the different weights vanishes in the December month of that year.

9.100 When a methodological change is introduced together with the annual weight updates, annual rates of change can sometimes be affected by the fact that indices 12 months apart are calculated according to different methods. The samples that can be renewed together with the weight update may also have different seasonal patterns than the samples that were priced in the previous year. Different seasonal patterns in the samples, combined with linking over a single month, could lead to distortions in the annual rates of the chain-linked index due to a permanent shift in the index level. Generally, this is the case when the index values of the old and new sample strongly differ in the linking month. Some form of parallel calculations may be needed in order to measure the impact of such changes. Ideally, the NSO should test alternative linking approaches in order to minimize any statistical distortions in the index series.

9.101 The resulting annually chained indices can in principle be presented in any index reference period. The index reference period corresponds to the period for which the index is set to 100. A price index expressed for instance as 2010 = 100 can be re-referenced or re-scaled to 2015 = 100 by simply dividing the 2010 indices by the arithmetic average of the 2010 indices for the 12 months of 2015. Apart from rounding errors, re-referencing should have no impact on monthly or annual rates of change. The index reference period may correspond to the first price reference period used in the series. Another option would be to update the index reference period from time to time, say every 10 years, or when major methodological changes are taking place. When the index reference period is changed, it may be useful to continue providing the results in the old reference period because some users may still need the index levels expressed in the old reference period.

9.102 Table 9.10 demonstrates the process for linking annual indices for multiple periods. The new index reference period in January 2015 was December 2014 = 100

[10]The contribution to change must be broken down into two components. The first component is the change from the relevant month in the previous year to the link month using the old weights and added to this is the (second component) change from the link month to the relevant month in the current year using the new weights.

Table 9.10 Linking Annual Indices for Multiple Periods with Chained Linking Factors

COICOP Code	Description	CPI Dec. 2014=100	CPI Dec. 2015 with Dec. 2014=100	Linking Factor Forward (2016 Series)	CPI Dec. 2016 with Dec. 2015=100	CPI Dec. 2016 with Dec. 2014=100	Linking Factor Forward (2017 Series)	CPI Dec. 2017 with Dec. 2016=100	CPI Dec. 2017 with Dec. 2014=100
(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)
01	**Food and Non-alcoholic Bev.**	**100.00**	**108.99**	**1.089859**	**103.69**	**113.01**	**1.130084**	**104.33**	**117.90**
01.1	**FOOD**	**100.00**	**108.91**	**1.089085**	**106.29**	**115.76**	**1.157578**	**106.87**	**123.71**
01.1.1	**Bread & Cereals**	**100.00**	**120.45**	**1.204490**	**103.75**	**124.96**	**1.249616**	**115.37**	**144.16**
01.1.101	Rice (white)	100.0	137.0	1.370003	135.4	185.4	1.854301	171.19	317.44
01.1.102	Rice (Brown)	100.0	137.9	1.379356	95.6	131.8	1.318197	121.70	160.42
01.1.103	Flour	100.0	122.6	1.225822	136.2	167.0	1.670136	154.19	257.52
01.1.104	Bread	100.0	115.6	1.156216	94.7	109.4	1.094450	101.04	110.58
01.1.105	Biscuits (Salted)	100.0	102.8	1.027706	59.6	61.3	0.612767	56.57	34.67
01.1.106	Cakes, Pastry, etc.	100.0	119.3	1.192797	99.4	118.6	1.186214	109.51	129.91
01.1.107	Chow Mein	100.0	113.8	1.137564	131.8	150.0	1.499635	138.45	207.62
01.1.109	Macaroni	100.0	96.2	0.962266	85.3	82.0	0.820352	75.74	62.13
01.1.110	Oat flakes	100.0	91.4	0.914144	96.0	87.8	0.877843	81.04	71.14
01.1.111	Sago	100.0	94.1	0.940671	94.9	89.2	0.892387	82.39	73.52
01.1.112	Tennis Rolls	100.0	114.5	1.145302	93.4	107.0	1.070218	98.80	105.74
01.1.113	*Whole Wheat Bread**	*100.0*	*115.6*	*1.156216*	*94.7*	*109.4*	*1.094450*	*101.04*	*110.58*
01.1.2	**Meat**	**100.00**	**101.70**	**1.016968**	**108.42**	**110.26**	**1.102645**	**101.80**	**112.25**
01.1.201	Stew Beef	100.0	100.5	1.004750	108.4	109.0	1.089502	100.58	109.59
01.1.205	Chicken (live)	100.0	102.3	1.023498	97.7	100.0	1.000247	92.34	92.37
01.1.206	Chicken (frozen)	100.0	100.2	1.002088	107.4	107.7	1.076706	99.40	107.03
01.1.207	Pork Leg	100.0	126.2	1.261643	205.7	259.5	2.595448	239.62	621.91
01.1.210	Corned beef	*100.0*	*101.7*	*1.016968*	*100.7*	*102.4*	*1.023703*	*94.51*	*96.75*
01.1.211	Duck	100.0	97.5	0.975450	63.1	61.5	0.615484	56.82	34.97
01.1.212	Liver	100.0	104.9	1.049449	84.5	88.7	0.886868	81.88	72.61
01.1.213	Mutton	100.0	97.1	0.970904	109.2	106.1	1.060580	97.91	103.85
01.1.214	Sausages (pork & chicken)	100.0	109.3	1.093397	99.1	108.4	1.083866	100.06	108.46
01.1.215	*Brisket**	*100.0*	*100.5*	*1.004750*	*108.4*	*109.0*	*1.089502*	*100.58*	*109.59*
01.1.3	**Fish & Seafood**	**100.00**	**96.93**	**0.969334**	**96.98**	**94.00**	**0.940030**	**86.78**	**81.58**

(column C). The NSO proceeded to update the weights in January 2016, January 2017, and January 2018, while maintaining the original index reference period of December 2014. In January 2015, new weights were introduced from 2013 and the new price reference period was set to December 2014 = 100. This is also the overlap month, so the indices are converted to long-term relatives and serve as the linking factors (column E) to tie to the next year's indices. In January 2016 weights were introduced from 2014 and the new price reference period was set to December 2015 = 100. The link factors from the previous year (column E) are applied to the new index levels for December 2015 (column F) to derive the current year index levels (column G) with December 2015 = 100. These indices are then converted to linking factors to use with the 2016 indices (column H). The same actions were taken in January 2017 with new weights from 2015 and a new index using December 2016 = 100. The previous year linking factors (column H) were applied to the December 2017 index (column I) to derive the index for December 2017 with December 2014 = 100 (column J).

9.103 The index levels in columns F and I reflect the levels of each index referencing the previous December (2015 and 2016, respectively). They are not calculated on the December 2014 reference period. This is accomplished by linking each of these periods together successively. As can be seen in Table 9.9, the chaining of the linking factors is similar to chaining the annual indices of the three-year period (December 2014 to December 2016). For example, the December 2017 index for the Food Group (COICOP 1999 01.1) of 123.71 is the product of chaining the price changes (indices converted to price relatives) for the three years (1.089085 × 1.0629 × 1.0687) to the December 2014 reference period index of 100.

Calculating Cntributions to Change

9.104 Contributions to change help explain those groups of goods and services that contribute most to inflation. These data are useful to better understand the sources of inflation and can contribute to greater transparency. Whether the weights are fixed for a period of time or updated annually, different formulas would apply.

Fixed Weight Indices

9.105 The formula used to calculate the contributions from the aggregates to the total index is as follows:

$$C_i^t = \frac{w_i^{t_0} * \left(I_i^t - I_i^{t-m}\right)}{I_{TOT}^{t-m}} \tag{9.20}$$

where
C_i^t: contribution of aggregate i in period t
$w_i^{t_0}$: weight of aggregate i in period t_0
I_i^t: index of aggregate i in period t
I_i^{t-m}: index of aggregate i in period t-m
I_{TOT}^{t-m}: total index in period t-m

9.106 The addition of individual contributions is equal to the published rate of change. It should be noted that this formula may only be applied if the weights remain constant. When the weights change, in the case of a chained index, the additivity of individual contributions does not provide exactly the published rate of change. However, estimates are possible as shown in the section that follows on annual weight updates. When the comparison period t-m to t crosses over a link period k, then the contribution must be calculated separately for each period (t-m to k and k to t) and combined.

Annual Weight Updates[11,12]

9.107 When expenditure weights are annually updated, price indices spanning more than a year are chain-linked and the formula to compute contributions to inflation between month *m* of year *(y-1)* and month *m* of year *y* needs to be modified. The annual inflation rate denoted by $\pi TOTy,m$ can thus be decomposed as follows, assuming that each year the new weights are introduced with the December to January link:

$$\begin{aligned}
\pi_{TOT}^{y,m} &\equiv \frac{I_{TOT}^{y,m}y,m - I_{TOT}^{y-1,m}}{I_{TOT}^{y-1,m}} \\
&= \frac{I_{TOT}^{y-1,12}}{I_{TOT}^{y-1,m}} \sum_j \left[w_j^{y-1,12} \frac{I_j^{y,m}}{I_j^{y-1,12}} \right] - \frac{I_{TOT}^{y-2,12}}{I_{TOT}^{y-1,m}} \sum_j \left[w_j^{y-2,12} \frac{I_j^{y-1,m}}{I_j^{y-2,12}} \right] \\
&= \frac{I_{TOT}^{y-1,12}}{I_{TOT}^{y-1,m}} \sum_j \left[W_j^{y-1,12} \left(\frac{I_{TOT}^{y-1,12}}{I_j^{y-1,12}} \right) - 1 \right] + \underbrace{\frac{I_{TOT}^{y-1,12}}{I_{TOT}^{y-1,m}}}_{= \frac{I_{TOT}^{y-2,12}}{I_{TOT}^{y-1,m}} \sum_j \left[w_j^{y-2,12} \frac{I_j^{y-1,12}}{I_j^{y-2,12}} \right]} \\
&\quad - \frac{I_{TOT}^{y-2,12}}{I_{TOT}^{y-1,m}} \sum_j \left[W_j^{y-2,12} \frac{I_j^{y-1,m}}{I_j^{y-2,12}} \right] \\
&= \frac{I_{TOT}^{y-1,12}}{I_{TOT}^{y-1,m}} \sum_j \left[W_j^{y-1,12} \left(\frac{I_j^{y,m}}{I_j^{y-1,12}} \right) \right] \\
&\quad + \frac{I_{TOT}^{y-2,12}}{I_{TOT}^{y-1,m}} \sum_j W_j^{y-2,12} \left(\frac{I_j^{y-1,12} - I_j^{y-1,m}}{I_j^{y-2,12}} \right)
\end{aligned} \tag{9.21}$$

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

$$\begin{aligned}
Contrib_j^{y,m} &= \left[\left(\underbrace{\frac{I_{TOT}^{y-1,12}}{I_{TOT}^{y-1,m}}}_{(1)} * \underbrace{W_j^{y-1,12}}_{(2)} \right) * \left(\underbrace{\frac{I_j^{y,m} - I_j^{y-1,12}}{I_j^{y-1,12}}}_{(3)} \right) \right] \\
&\quad + \left(\underbrace{\frac{I_{TOT}^{y-2,12}}{I_{TOT}^{y-1,m}}}_{(4)} * \underbrace{W_j^{y-2,12}}_{(5)} \right) * \left(\underbrace{\frac{I_j^{y-1,12} - I_j^{y-1,m}}{I_j^{y-2,12}}}_{(6)} \right)
\end{aligned} \tag{9.22}$$

[11] For detailed methodology, see http://www.oecd.org/sdd/prices-ppp/OECD-calculation-contributions-annual-inflation.pdf

[12] See also *Harmonized Index of Consumer Prices (HICP) Methodological Manual,* Section 8.5.3, https://ec.europa.eu/eurostat/web/products-manuals-and-guidelines/-/KS-GQ-17-015

Notations:
$W_{jy}-1,12$ is the expenditure weight corresponding to COICOP component *j* in December of year *(y-1)* and used for the link from December of year *(y-1)* until December of year *y*;
I_{TOT}, is the overall price index in month *m* of year *y*;
I_j, is the price index of component *j* in month *m* of year *y*;

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

9.110 Note that when m = 12 (December), the second part of the formula is equal to zero and the first part simplifies as follows, which leads to the same contribution formula as in the fixed basket case when $y^0 = y - 1$ and $m^0 = 12$:

$$Contrib_j^{y,12} = \underbrace{W_j^{y-1,12}}_{(2)} * \underbrace{\frac{I_j^{y,12} - I_j^{y-1,12}}{I_j^{y-1,12}}}_{\equiv \pi_j^{y,12}:(3)} \tag{9.23}$$

9.111 Alternative approaches to calculating the contributions to change are possible. First, when the weights are fixed, the relative change of the index from *t-m* to *t* can then be written as:

$$\frac{I^{0:t}}{I^{0:t-m}} - 1 = \frac{\sum w_j^b I_j^{0:t-m} I_j^{t-m:t}}{\sum w_j^b I_j^{0:t-m}} - 1 \tag{9.24}$$

Hence, a sub-index, j, from t-m to t enters the higher-level index with a weight of:

$$\frac{w_j^b I_j^{0:t-m}}{\sum w_j^b I_j^{0:t-m}} = \frac{w_j^b I_j^{0:t-m}}{I^{0:t-m}} \tag{9.25}$$

The effect on the higher-level index of a change in a sub-index can then be calculated as:

$$Effect = \frac{w_j^b I_j^{0:t-m}}{I^{0:t-m}} \left(\frac{I_j^{0:t}}{I_j^{0:t-m}} - 1 \right) = \frac{w_j^b}{I^{0:t-m}} \left(I_j^{0:t} - I_j^{0:t-m} \right) \tag{9.26}$$

With $m = 1$, the formula **9.27** gives the effect of a monthly change; with $m = 12$, it gives the effect of the change over the past 12 months.

9.112 If the weights have been updated, then a sub-index, *j*, from *t-m* enters the higher-level index with a weight of:

$$\frac{w_j^k I_j^{k:t-m}}{I^{k:t-m}} = \frac{w_j^k \left(I_j^{0:t-m} / I_j^{0:k} \right)}{\left(I^{0:t-m} / I^{0:k} \right)} \tag{9.27}$$

9.113 The effect on the higher-level index of a change in a sub-index then is:

$$\begin{aligned} Effect &= \frac{w_j^k}{I^{k:t-m}} \left(I_j^{k:t} - I_j^{k:t-m} \right) \\ &= \frac{w_j^k}{\left(I^{0:t-m} / I^{0:k} \right)} \left(\frac{I_j^{0:t} - I_j^{0:t-m}}{I_j^{0:k}} \right) \end{aligned} \tag{9.28}$$

It is assumed that *t-m* lies in the same link (i.e. *t-m* refers to a period later than *k*). If the effect of a sub-index on a higher-level index is to be calculated across a chain, the calculation needs to be carried out in two steps: one with the old series up to the link period, and one from the link period to period *t*.

9.114 The calculation of the effect of a change in a sub-index on a higher-level index is illustrated in Table 9.11. The index is calculated in one link so that equation 9.26 may be applied for the decomposition. For instance, the effect in percentage points of the increase for housing from January 2018 to January 2019 can be calculated as 0.25/118.6 × (120.0 – 110.0) = 2.11 percentage points. This means that, of the increase of 10.03 per cent in the all-items index, 2.11 percentage points can be attributed to the increase in the index for housing.

Introducing New Classification Systems

9.115 Chapter 2 recommends that countries adopt the United Nations' COICOP. Many countries that have been using a national product classification system will want to introduce the COICOP at the time of their next CPI revision in order to meet the recommendations of this Manual. The introduction of COICOP may cause a break with the old classification system. For example, COICOP 2018 classifies household final consumption expenditure into 13 Divisions

Table 9.11 Decomposition of Index Changes

	Weight	Index			Change in % from Jan. 18 to Jan. 19	Effect (contribution)	
		2015	Jan. 18	Jan. 19		% points of total change	% of total change
Food	0.30	100.0	120.0	130.0	8.33	2.53	25.21
Clothing	0.10	100.0	130.0	145.0	11.54	1.26	12.61
Housing	0.25	100.0	110.0	120.0	9.09	2.11	21.01
Transport	0.20	100.0	125.0	130.0	4.00	0.84	8.40
Miscellaneous	0.15	100.0	114.0	140.0	22.81	3.29	32.77
Items	1.00	100.0	118.6	130.5	10.03	10.03	100.00

as shown in Annex 2. Countries who have not adopted COICOP often have classifications with 9 or 10 Divisions. Both classification systems will cover the detailed items, but they are often classified in different Divisions. One common area of difference is food eaten at restaurants, cafes, canteens, and kiosks. COICOP includes these expenditures in Division 11 Restaurants and Accommodation Services, while the national classification may include these in Division 01 Food and Non-Alcoholic Beverages.

9.116 When the NSO is ready to introduce the revised CPI using the COICOP, there will be a difference in the old and new classification structures for the published indices. Some Divisions such as Clothing and Footwear and Health may be the same. Others such as Furnishings, Household Equipment, and Routine Household Maintenance (where televisions and video equipment are moved to Entertainment).will have differences in the detailed components

9.117 In most instances, the old CPI includes the same detailed components as the COICOP, but the components appear in different divisions. If this is the case, it may be a straightforward task to develop a concordance between the old classification and the COICOP. The old index series at the detailed level can be recompiled using the old series weights to reflect the COICOP structure at the 13 Division level. The recompiled old series can then be linked with the new COICOP series to form a time series going back to the point of the previous revision. For example, assume the last revision was on a 2010 =100 reference period and introduced in January 2013. These series can be recompiled to form COICOP Division level indices for January 2013 through December 2017. The new COICOP series is introduced in January 2018 with 2015 = 100 reference period. The old series can be linked to the new series at the Division and Total CPI levels using 2015 = 100 as the overlap period. The old series can be re-referenced to the 2015 annual average = 100 if a new reference base is introduced.

9.118 Alternatively, if the NSO decides to keep the 2010 =100 reference period, the changes in the revised CPI can be applied to the old index series at the COICOP Division level. In this latter instance, the new series must be compiled for both December 2017 and January 2018 on the 2015 = 100 reference period and the monthly price relative for January 2018 is applied to the recompiled old series at the Division and Total CPI levels on the 2010 = 100 reference period. This process is carried out each month going forward in time. Note that the new weights are applied to the revised index levels with 2015 = 100. They are not applied and are not relevant for the old series with 2010 = 100. The new weights refer to the CPI structure in 2015, not the structure from 2010.

9.119 It is important for the NSO to advise users about changes that are made to the CPI, particularly when a revision takes place. When the NSO updates the index reference period, users will generally take note of the change and ask about the difference between the old and revised series. The NSO should provide users with the information about all the changes taking place including new weights, new item structure, and improvements in methods and procedures. Users also need to be aware that the series are not strictly comparable. Some items may have been dropped from coverage and others added. For example, radios, tape recorders, and stereo systems may no longer be important items in the basket and may be replaced with Bluetooth speakers and other audio media. In addition, electronic items such as tablets and e-readers may be added. In some instances, owner-occupied housing may now be represented whereas only rental units were included previously.

9.120 When the NSO does not change the index reference period (i.e., keeps the old reference period), it is less obvious to users that a change has taken place. This is particularly true when it has been several years since the last CPI revision. If the weights are updated annually, users may be aware of the change in weighting; however, when revisions only take place every five to ten years, the NSO needs to make extra efforts to ensure that users are aware of changes and discontinuities in series.

Expanding CPI Geographic Coverage

9.121 Many countries have CPIs with limited geographic coverage—capital city, two or three of the largest areas, large and medium-sized cities—when they are first developed. Over time as the CPI becomes more important in economic planning and inflation monitoring, and population centers expand, efforts are made to expand the CPI to cover more geographic areas including all urban and rural areas. Generally, this expansion takes place by increasing the coverage of the HBS so that representative baskets can be developed for more geographic areas.[13] As new geographic areas are added to the CPI, the comparability between the previous index and the revised index becomes questionable. In these cases, linking the aggregate indices to the previous measures needs to be done with caution and users advised about the differences in coverage.

9.122 In some countries, NSOs first produce a CPI for the capital city only and, as resources become available for subsequent CPI revision, they expand to cover more areas. As the revised CPI is introduced, estimates should be provided for both the capital city and for the new areas in addition to the all-items index. In such a case, the capital city index for the revised CPI can be linked to the previous capital city index with meaningful results in that the geographic coverage has not changed even though the structure of consumer spending patterns may differ.

9.123 However, linking the revised CPI with expanded geographic coverage (perhaps with two or more new areas) needs to be done with caution. The NSO assumes when it produces such a linked series that the historical price changes for the new coverage would be the same as that for old coverage. The NSO can evaluate the differences in the baskets among the new areas with that for the old area to determine how similar or different the baskets and price trends might be. If there are significant differences between the areas (e.g., the capital city may have substantially more weight for housing, clothing, and education, and substantially less for food and transport than the new areas), then

[13] In some cases, the expansion may take place by using an existing basket such as that for the capital city or urban areas in conjunction with broader data collection in targeted geographic locations. In such instances it is assumed the basket is very similar across areas as described in Chapter 3.

the NSO should not link the aggregate old and new series. Rather, they should continue to produce the CPI series for comparable geographic areas and link these series to form a time series. The new geographic areas and the new aggregate CPI should be published separately as new series and not linked with old series.

9.124 At the same time, if the CPI already had broad coverage such as all urban areas and the weight structure included all urban areas, then the aggregate series for the all-urban CPI might be linked together as the city sample is expanded. For example, the previous CPI could have included five urban areas (but their weights represented all urban areas) and now the number of urban areas in the city sample is expanded to include eight urban areas whose weights also cover all urban areas. In this instance, the NSO could still derive meaningful comparisons for price change for all urban areas by linking the all urban index for the old series with that for the new series using the larger sample. The basket has changed so the series are not strictly comparable, but the new, larger sample would have more precision because of the increased sample size compared to the old. If city indices were also produced, those with the same geographic coverage could be linked to form a time series.

9.125 If the NSO went one step further and included total national coverage by adding a sample of rural areas to the CPI, it would need to do an analysis of the differences in the baskets and price trends before linking the old urban series to the new national coverage. In this instance the NSO would not link the urban and national series together; the national series should start as a new CPI with broader coverage.

Key Recommendations

- NSOs should update the basket, update the weights, and link the revised CPI to the previous series to form a continues time series of data.
- Reduce the lag between the weight reference period and the price reference period.
- NSOs should carefully consider the advantages and disadvantages of price updating the weights, based on the target of the CPI and its primary uses.
- If a CPI is updated less frequently, a one-year price reference period is preferred.
- If a CPI is updated on a more frequent basis (annually, biannually), a one-month price reference period is used.
- If resource constraints do not allow for a one-year price reference period, a quarterly price reference period would be the second-best option and a monthly price reference period the third best option.
- A one-year index reference period is preferred for all CPIs.
- When using a one year overlap to link indices, the new index compiled as an overlap series for linking purposes should be used internally and not disseminated. When calculating the 12-month (year on year) change, the change should be calculated on the published linked index and not the internally compiled new index used for linking.