Chapter 9. Updating CPI Weights and Linking New to Previous CPI Series

1. In Chapter 3, recommendations are made to update the weights used in the CPI compilation on a periodic basis. The preferred interval is at least once every five years. This chapter discusses the processes and procedures for introducing new weights and basket in the CPI as well as approaches for linking the new and previous CPI series following the introduction of new weights. It includes many 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 an HES.

2. The target audience for this guidance is CPI compilers. Many other CPI users such as central banks, finance ministries, business decision makers, and academic researchers may also find it helpful. It provides a better knowledge and understanding of how the CPI baskets are derived and maintained. Users should find this information useful background when using the CPI for making policy decisions or conducting research activities.

I. UPDATING WEIGHTS FOR PRICE CHANGE: PROS AND CONS

A. Approaches to updating weights

3. 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 weights (Young index) which keeps the expenditure shares fixed. This chapter examines what the choice of the updating method should be using some objective criteria.

4. In the past, the target index for the CPI was a Laspeyres price index that was easy to explain to users. It is a fixed quantity basket price index, with quantities held fixed in the price reference period. This manual has helped to clarify that the target index for the CPI should be the Fisher, Törnqvist, or Walsh price indexes, not the Laspeyres index. Chapter 17 (Vol. 2) demonstrates that these three indexes 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 in which the household expenditure survey (HES) took place, of a CPI is generally earlier than the price reference period of the index. To derive an index that commences from its price reference period =100 but keeps quantity weights fixed in the earlier weight reference (survey) 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 issue as to which index currently produced by NSOs would best approximate the target indexes: the Lowe index with price updated weights or the Young index that simply uses the weights from the weight reference period.

B. Recent research on the whether or not to price-update weights

5. 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 prices of a product usually purchased rises relative to other similar products, consumers will 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—more purchased of the product with the relative decline in prices and less of the products with the relative increases. This consumer reaction to price movements is the theory underlying the downward sloping demand curve.

6. Given this behavior, Chapter 17 (Vol.2) outlines why the Laspeyres price index will be an upper bound to the true cost of living index and the Paasche price index will be a lower bound (paragraphs 17.15-17.17). It also shows subsequently that the three target indexes—Fisher, Törnqvist, and Walsh—are very close approximations to one another and to the true cost of living index.

7. 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 items with relatively large increases in price gain an unduly large expenditure share in period 0 relative to *b* (where *b* precedes 0). Balk and Diewert (2003), Balk (2010), and paragraphs 17.78-17.83 show that the Lowe index has an upward substitution bias compared to the true cost of living index. This bias increases the longer the period between the weight reference period (*b*) and the price reference period (0). The *Manual* 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 our target indexes, as well as the Laspeyres index.

8. The dispersion of price change over the period affects the magnitude of the substitution bias. In the unlikely event of all prices changing in the same proportion, then 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, we would expect the dispersion in prices to increase and price-updating to 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 indexes (and the Laspeyres index also).

9. An alternative approach would be to use the weights from the weight reference period directly. Boldsen Hanson (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 implies that consumer substitution behavior exhibits unitary elasticity—consumer shifts in reducing the quantities purchased are in the same proportion as the increase in prices.

10. Whether the Young index is biased relative to the target indexes will depend on the elasticity of substitution. If the elasticity is lower than one (inelastic), the Young index will have a downward bias compared to the targets. 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 will have an upward bias because consumers tend to substitute more than assumed.

11. Recent studies of the potential bias in the Young and Lowe indexes indicate that measured price changes using the Lowe index generally exceed those of the Young index and both exceed the target indexes. Boldsen Hansen (2007) using Danish CPI data, Greenlees and Williams (2010) and Armknecht and Silver (2013) using U.S. CPI data, and Pike *et al*. with New Zealand 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 price index.

12. Armknecht and Silver (2013) also suggest that there are practical solutions to simulate a target index. They provide evidence from the methodology proposed by Lent and Dorfman (2009) that using the geometric average of arithmetic indexes such as Young or Lowe with geometric indexes such as geometric Lowe or geometric Young, respectively, can closely approximate the Fisher or Törnqvist indexes. NSOs should be able to produce these four indexes using the expenditure data they have available to them from the HES. First they

can calculate the Young and Lowe indexes with the HES weights and the price-updated weights. Next, they 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 indexes.

C. Should NSOs use the Lowe or the Young index (to price update or not)?

13. The recent evidence suggests that price updating weights before introducing them in the CPI may not be the best approach for the CPI. Consumer theory indicates that if prices have risen between *b* and 0, there should be some shift in the structure of the quantities purchased. If no such shifts take place, there is no substitution in consumer purchases. In this case, the NSO should price-update the weights, thus holding quantities constant in period *b*, and compile a Lowe index. If it is clear that consumer substitution is taking place, then the appropriate formula for an NSO depends on the nature and extent of the substitution. There are two approaches: (i) to estimate or make some judgment about the elasticity of substitution and use it to determine the appropriate formula; (ii) to use superlative index number formulas—such formulas can to an extent accommodate different degrees of substitution behavior—or an approximation to it, as discussed below.

14. A good measure of the degree of substitution is the elasticity of substitution. If no or very little substitution is taking place, the elasticity will be equal to or close to zero. In this case, the NSO should price-update the weights for price changes from *b* to 0 and compile a Lowe index. If consumer substitution is taking place and the changes in quantities (downward) are about the same proportion as changes in prices (upward) to leave expenditure shares roughly constant, then the elasticity is unitary. In this case, the NSO should use the weight reference period shares directly and compile a Young index.

15. The NSO usually will not have information on the elasticity of substitution (η). Feenstra and Reinsdorf (2007), provide a relatively straightforward method, albeit with limitations, for estimating η by using the change in the expenditure shares over a period of time along with the change in prices. The NSO should have both the original and new data sets available to them. The Feenstra-Reinsdorf approach (their equation 12) is to estimate η from a linear regression where the change in the natural logarithms of the shares ($\Delta \ln s_{it}$) is regressed on the natural logarithm of the change in prices ($\Delta \ln p_{it}$):

$$\Delta \ln s_{it} = \alpha_t - (\eta - 1)\Delta \ln p_{it} + \varepsilon_{it}$$

The coefficient from the change in prices in the linear regression is then used to estimate η.

16. Table 1 shows the type of information needed for estimating this regression equation. The first two columns have the COICOP codes and the titles for the groups, classes, and items. In this example, we have only included food and beverage items since they are the most numerous in the CPI. In calculating the regression equation NSOs would want to include all of the CPI items, and then experiment by including dummy variables for different groups to test whether η is stable across product groups. The implication of instability is that more than one formula might be used to better address substitution bias. The third and fourth columns have the expenditure shares for the old basket (2010) and the new basket (2015). The next column has the average 2015 CPI on the 2010 = 100 base period. The last column has the change in the shares (2015 share minus 2010 share).

Table 1: Expenditure Shares for Previous and Current HES

COICOP Code	Item Name	Expenditure Share 2010	Expenditure Share 2015	Avg. CPI 2015	Δ Share
01	**Food and Nonalcoholic Beverages**	**100.00**	**100.00**		
01.1	**FOOD**	**94.830**	**93.306**		
01.1.1	**Bread & Cereals**	**22.414**	**21.419**		
01.1.101	Rice (white)	5.759	1.406	**150.70**	-4.35
01.1.102	Rice (Brown)	0.381	3.361	**151.73**	2.98
01.1.103	Flour	4.356	2.578	**134.84**	-1.78
01.1.104	Bread	6.167	6.864	**127.18**	0.70
01.1.105	Biscuits (Salted)	1.083	0.813	**113.05**	-0.27
01.1.106	Cakes, Pastry, etc.	0.375	1.034	**131.21**	0.66
01.1.107	Chow Mein	1.370	1.716	**125.13**	0.35
01.1.109	Macaroni	0.426	1.284	**105.85**	0.86
01.1.110	Oat flakes	0.751	0.450	**100.56**	-0.30
01.1.111	Sago	0.535	0.341	**103.47**	-0.19
01.1.112	Tennis Rolls	0.589	1.392	**125.98**	0.80
01.1.113	***Whole Wheat Bread****	0.622	0.180	**127.18**	-0.44
01.1.2	**Meat**	**17.358**	**17.632**		
01.1.201	Stew Beef	4.499	1.940	**110.52**	-2.56
01.1.205	Chicken (live)	1.577	1.038	**112.58**	-0.54
01.1.206	Chicken (frozen)	8.904	10.202	**110.23**	1.30
01.1.207	Pork Leg	0.473	0.610	**138.78**	0.14
01.1.210	***Corned beef****		0.866	***111.87***	
01.1.211	Duck	0.291	0.217	**107.30**	-0.07
01.1.212	Liver	0.245	0.207	**115.44**	-0.04
01.1.213	Mutton	0.319	0.271	**106.80**	-0.05
01.1.214	Sausages (pork & chicken)	1.049	1.823	**120.27**	0.77
01.1.215	***Brisket****		0.458	**110.52**	
01.1.3	**Fish & Seafood**	**4.483**	**5.982**		
01.1.301	Grouper	1.142	1.822	**94.54**	0.68
01.1.302	Sea Trout	0.785	0.989	**109.78**	0.20
01.1.303	Salted fish	0.431	0.986	**116.24**	0.55
01.1.304	Butter fish	0.503	0.256	**98.82**	-0.25
01.1.305	Shrimp, fresh	0.426	0.454	**140.15**	0.03
01.1.307	Grey snapper	0.581	0.366	**100.85**	-0.21
01.1.308	Red snapper	0.393	0.259	**100.85**	-0.13
01.1.309	Sardines	0.221	0.851	**117.72**	0.63
01.1.4	**Milk, Cheese & eggs**	**13.383**	**10.965**		
01.1.401	Eggs	2.442	1.618	**116.54**	-0.82
01.1.402	Fresh milk	1.209	0.331	**111.43**	-0.88
01.1.404	Evaporated milk	0.622	0.445	**105.78**	-0.18
01.1.405	Powdered milk	6.603	6.348	**101.52**	-0.26
01.1.406	Cheese	2.507	2.223	**105.70**	-0.28
01.1.5	**Oils & Fats**	**6.731**	**5.573**		
01.1.501	Butter, fresh	0.307	0.269	**113.94**	-0.04
01.1.503	Margarine	2.669	1.435	**106.83**	-1.23
01.1.504	Peanut butter	1.155	1.194	**103.18**	0.04
01.1.506	Fry Oil/Vegetable Oil	2.600	2.674	**120.56**	0.07
01.1.6	**Fruits**	**5.203**	**5.706**		
01.1.601	Oranges	1.398	0.990	**68.27**	-0.41
…	…	…	…	**…**	…
…	…	…	…	**…**	…

17. With these data, the NSO should be able to estimate η using the regression approach. One should take the following steps:

i. Calculate the natural logarithm (ln) of the item shares present in both 2015 (ln 2015 shares) and 2010 (ln 2010 shares). There are 90 in this example.
ii. Subtract the 2010 natural log from the 2015 natural log (**Δ ln of Shares)**.
iii. Convert the price indexes to price relatives by dividing by 100.
iv. Calculate the natural log of the price relatives (**ln Price Rel**).
v. Calculate the weights for each observation as **Δ Share / Δ ln of Shares.**
vi. Sum the column of weights.
vii. Calculate normalized **Weights** (i.e., weights that sum to 1.0 by dividing by the sum of the weights in the previous step).
viii. Calculate a weighted linear regression with the **Δ ln of Shares** as the left hand variable and **ln Price Rel** and **Weights** as the right hand variables.

18. Appendix 1 provides a detailed example of the data and the calculations to derive the estimate of the slope and the intercept for the regression equation. The steps above appear at the head of each column of data in Appendix 1. The Excel formulas for calculating the slope and intercept for the regression are also provided at Appendix 1. The slope is used to derive the estimate of η. For the data in Table 1 the estimated slope of the regression equation is 0.0129. We derive the value for η as follows.

$$-(\eta - 1) = 0.0129$$
$$(\eta - 1) = -0.0129$$
$$\eta = 0.9871$$

19. Because the value of η is very close to 1.0, the NSO would conclude that consumers of this product group have unitary elasticity of substitution. In this case, they would want to use the Young index rather than the Lowe index. This means the NSO should use the weights for 2015 rather than price-updating the weights before introducing them. Of course an NSO deciding on whether to change their higher-level formula in, say 2017, is basing the judgment on evidence from 2010 to 2015 expenditure patterns.

20. Greenlees (2011) in a study of substitution elasticity for the United States found that they were highly volatile in successive years. He found the elasticity not being statistically significant when tested against null hypotheses of zero in one year and unity in the next. Should regular expenditure surveys be available, the NSO should also undertake estimates for sub-periods. The implication of such volatility is that a more flexible, albeit retrospective, formula should be used in addition to the headline CPI.

21. If the NSO is not able to estimate η, it will need to evaluate other data. We know that, on the one hand, if the CPI has been increasing over the 24 to 36 month period between *b* and 0 with substantial price increases (e.g. 4 percent or more per year), the Lowe index will most likely be biased upward. If prices are changing at 4 percent or more per year, it is likely that consumers are substituting away from the higher priced items. We know, on the other hand, if the elasticity of substitution is less than unitary, the Young index also has an upward bias. However, the NSO cannot know for certain whether this activity is closer to unitary elasticity or zero elasticity.

22. As noted earlier, the NSO has other options to consider. It can price update weights and calculate both a Lowe and geometric Lowe. Also, it can calculate a Young and a geometric Young. With these four indexes available the NSO can use a formula that is the geometric average of the Lowe and geometric Young or the Young and geometric Lowe to approximate the target indexes. The NSO should test this approach using historical data.

23. If the NSO is able to conduct a HES on a more frequent basis, for example annually or biannually, it could calculate the superlative Törnqvist index on a retrospective basis. As the new weights become available,

the NSO can compile the Törnqvist index using the weights from the previous HES and current HES with the price data for the interim period. It can continue to use these weights until the next HES is available and revise the index for the new interim period.

24. It may be that more pragmatic factors influence the decision as to whether or not to price update the weights. Major changes to a classificatory systems, addition and deletion of new and old representative products, extension of the geographical areas, and change in methodology from a previously biased one, at the time of reweighting make it problematic to reliably price-update the weights.

II. DETAILED METHODS FOR UPDATING WEIGHTS

A. Decide on price reference base for calculating the revised CPI

Annual price reference periods

25. As the new weights are developed from the HES, the NSO must decide on what time period to use for the new price reference period.[1] 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.

26. A single year is preferred as the price reference period for infrequently rebased CPIs. Were a single month (or quarter) 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. Further, if a single unusual price reference month is to act as the index reference period (=100. the initial impression of the index change may be a distorted one. Preferable is that the price reference period is a whole year in which seasonal prices would be appropriately represented. In some months there will be no sales of a, for example, 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, the *Manual* recommends, data permitting, that 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 HES. 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.

27. If the NSO chooses the annual period, it will need annual average prices for all items. 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 say for 2017 will be collected and used for the monthly index compiled and published for 2017, however the prices for the supplementary specifications/products for the new index should be collected alongside them for the rebased index to commence in January 2018, or soon afterwards, with 2017=100.

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

[1] There are three reference periods used for price index calculation. The price reference period is the time period for the base price used in the index constructions. The weight reference period is the time period for the weights used in the index. The index reference period is the period when the index is set to 100. For a Laspeyres index the weight and price reference periods are the same.

require prices to be collected for some new specifications and products in new outlets. Resources have to be committed in advance to plan for this. The sampling of products and broad item specifications and the concomitant outlet selection provides the basis for determining the new products/item specifications to be sampled and the old ones replaced.

29. Some of the specifications 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 specifications. 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, as outlined below.

30. It is often 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 price statisticians have to wait until the results of the expenditure survey have been compiled and new elementary aggregates determined to know what to price. The purpose of rebasing is to update the products and specifications priced and this needs to be informed by results from the survey. For example, the expenditure survey 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 (say using cut-off sampling) and their broad specifications; (iv) use of centrally-determined prices for selected products determined; 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 specification. This may commence in January 2017 or later depending on the resources of the statistical office. 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.

31. Statistical offices that use the two-stage (modified) Laspeyres method in which prices are compared to previous month's prices have the advantage of being able to readily introduce replacement products/specifications 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

32. Chained CPIs that annually update their weights with a relatively small time lag between the weight and index reference period often use a single month 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.

33. While for infrequently rebased CPIs the use of a single-month link is not advised, it is often the case that the resources of a country 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 above that 6-monthly is preferred to quarterly, and quarterly to monthly. The principles for using a monthly price reference period are similar to those of annual one, the issue being to mitigate as much as possible its shortcomings.

34. A primary shortcoming 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 carry-forward method is used and the month's imputed price in the price reference period for the out-of-season item may be unduly low. As mentioned above, the two-stage Laspeyres aggregation is preferred since it absolves a need for long-run price comparisons with this one-month price reference period.

35. Table 2 provides an illustrative calculation for updating price weights but uses a single month as the price reference period and thus illustrates some the compilation mechanics involved.

B. A Laspeyres index calculated retrospectively

36. A few statistical offices re-reference both the new and old indexes to the weight reference year; the weight reference period is set equal to 100. The advantage of keeping the weight reference period and price reference period the same is that the resulting price index will be a Laspeyres index. The procedure is not without problems but it is not clear that this has any measurement benefits. Consider for example a weight reference period of 2015 for which the new sample of products/specifications 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, we use 2015 = 100. As explained below, this is achieved by back casting the 2017 prices to 2015, a procedure that may involve some imputations. Nonetheless, were we to undertake the compilation, what is derived is a Laspeyres index with weight and price reference periods the same. However, we already have monthly index data for 2016 and 2017, albeit based on a previous weighting. Our interest in compiling the new rebased index is for CPIs from January 2016 onwards and their short-term price changes. The period-to-period indexes will be Lowe index number price comparisons, not Laspeyres. The ratio of two Laspeyres formulas is a Lowe formula; if March 2016 is 102.45 and April 2016 is 103.42, the monthly inflation over these two periods is (103.84/102.45-1)*100=1.36 percent. This measure is a Lowe index. The calculation of a Laspeyres index is not without problems.

37. The NSO often has difficulty in obtaining price measures for new items that it is introducing with the new weights. Because of the time lag between the HES and the development of the CPI weights, the required price data to use as base 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 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 weight reference period.

38. The alternative is to use price indexes 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 =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.

39. 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 a member may be used to reflect the price change from the weight reference period. Table 2 demonstrates this approach. It shows the weights for the 2010 and 2015 weight reference periods. It is possible using these data to revise the CPI using the new basket with the price reference and weight reference period the same (2015=100).

40. The example in Table 2 is for the COICOP Meat class of the CPI. The old basket consists of eight items from the 2010 HES while the new basket consists of ten items from the 2015 HES. Two new items (corned beef and brisket) will be introduced. The NSO decides that the new basket will be introduced using 2015 as the price and weight reference periods in January 2016. To accomplish this, the item indexes for the 2010 based index must be referenced to 2015=100.

41. The first issue the NSO faces is that it does not have 2015 prices for the new items. It will use the same prices and indexes that are available for the old items, but the new items require special treatment. In this situation there are two options: (a) use the price change of a similar item as representative of the new item's price movements, or (b) use the average price change for the class as the representative change.

42. In this example, brisket is a very similar cut of beef as stew beef so the NSO uses the price change for stew beef to represent that for brisket. The NSO does not believe that there is a similar product among the old items for corned beef and decides to use the price trend of the higher level meat class to represent the change in the revised index. This is accomplished by using the old index series for stew beef (columns 5 and 6) for the brisket index and the old index for Meat as the index for corned beef, respectively, in the new basket (columns. 7 and 8 in *italics*).

Table 2: Introducing the New Basket with the Same Weight and Price Reference Periods

		Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	Col. 8.	Col. 9
COICOP Code	**Item Name**	**Expenditure Share 2010**	**Expenditure Share 2015**	**Avg. CPI 2015 (Old Basket)**	**CPI Dec. 2017 (Old Basket)**	**Avg. CPI 2015 (New Basket)**	**CPI Dec. 2017 (New Basket)**	**CPI Dec. 2017 (2015 = 100)**
01.1.2	**Meat**	**17.358**	**17.632**	**111.87**	**236.56**			**225.78**
01.1.201	Stew Beef	4.499	1.940	110.52	254.82	110.52	254.8	230.56
01.1.205	Chicken (live)	1.577	1.038	112.58	229.66	112.58	229.7	203.99
01.1.206	Chicken (frozen)	8.904	10.202	110.23	252.50	110.23	252.5	229.07
01.1.207	Pork Leg	0.473	0.610	138.78	483.44	138.78	483.4	348.35
01.1.210	***Corned beef****		***0.866***			***111.87***	***236.56***	***211.46***
01.1.211	Duck	0.291	0.217	107.30	148.28	107.30	148.3	138.19
01.1.212	Liver	0.245	0.207	115.44	198.59	115.44	198.6	172.03
01.1.213	Mutton	0.319	0.271	106.80	256.71	106.80	256.7	240.36
01.1.214	Sausages (pork & chicken)	1.049	1.823	120.27	232.95	120.27	233.0	193.68
01.1.215	***Brisket****		***0.458***			***110.52***	***254.82***	***230.56***

**** New CPI Item***

43. The next step is to re-reference the CPI indexes with 2010=100 to the new reference period of 2015=100 by dividing the data in column 8 for Dec. 2017 by the data in column 7 and multiply by 100 to derive the rebased index levels for 2015=100. These indexes appear in column 9 and are available to use with the item price relatives for January to calculate the January 2016 indexes.

C. Developing update factors

44. The example in Table 2 demonstrated how the NSO can maintain the same weight and price reference period, thus producing a Laspeyres index. Most NSOs choose to use a more current period to introduce the new weight structure. Following the previous example, assume the NSO decides to introduce the new weights from the 2015 HES 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 before, the first choice will result in a Young index while the second will result in a Lowe index.

45. Table 3 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 above, in practice the whole year 2017 should 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 that is discussed in Section III.

46. 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 change for the items 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

Table 3: Updating Weights for Price Change from Weight Reference Period

		Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	Col. 8
COICOP Code	**Item Name**	**Expenditure Share 2015**	**Avg. CPI 2015**	**CPI Dec. 2017**	**Update Factor**	**Updated Weight**	**Normalized Weight**
					Col 5/4	Col. 6x3	
01	**Food and Nonalcoholic 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	2.1106	2.969	1.435
01.1.102	Rice (Brown)	3.361	151.7	224.6	1.4801	4.975	2.405
01.1.103	Flour	2.578	134.8	320.2	2.3745	6.121	2.959
01.1.104	Bread	6.864	127.2	222.4	1.7490	12.006	5.803
01.1.105	Biscuits (Salted)	0.813	113.0	140.1	1.2395	1.008	0.487
01.1.106	Cakes, Pastry, etc.	1.034	131.2	233.7	1.7812	1.842	0.891
01.1.107	Chow mein	1.716	125.1	309.8	2.4758	4.247	2.053
01.1.109	Macaroni	1.284	105.8	200.3	1.8927	2.429	1.174
01.1.110	Oat flakes	0.450	100.6	225.7	2.2442	1.010	0.488
01.1.111	Sago	0.341	103.5	222.9	2.1545	0.735	0.355
01.1.112	Tennis Rolls	1.392	126.0	219.6	1.7430	2.426	1.173
01.1.113	***Whole Wheat Bread****	0.180	***127.2***	***222.4***	1.7490	0.315	0.152
01.1.2	**Meat**	**17.632**				**39.81**	**19.24**
01.1.201	Stew Beef	1.940	110.5	254.8	2.3056	4.474	2.162
01.1.205	Chicken (live)	1.038	112.6	229.7	2.0399	2.117	1.023
01.1.206	Chicken (frozen)	10.202	110.2	252.5	2.2907	23.370	11.296
01.1.207	Pork Leg	0.610	138.8	483.4	3.4835	2.123	1.026
01.1.210	***Corned beef****	0.866	***111.9***	***236.6***	2.1146	1.832	0.885
01.1.211	Duck	0.217	107.3	148.3	1.3819	0.300	0.145
01.1.212	Liver	0.207	115.4	198.6	1.7203	0.356	0.172
01.1.213	Mutton	0.271	106.8	256.7	2.4036	0.651	0.315
01.1.214	Sausages (pork & chicken)	1.823	120.3	233.0	1.9368	3.531	1.707
01.1.215	***Brisket****	0.458	***110.5***	***254.8***	2.3056	1.056	0.511
01.1.3	**Fish & Seafood**	**5.982**				**12.66**	**6.12**
01.1.301	Grouper	1.822	94.5	233.5	2.4702	4.500	2.175
01.1.302	Sea Trout	0.989	109.8	135.3	1.2325	1.218	0.589
01.1.303	Salted fish	0.986	116.2	478.0	4.1119	4.055	1.960
01.1.304	Butter fish	0.256	98.8	123.0	1.2443	0.318	0.154
01.1.305	Shrimp, fresh	0.454	140.1	154.4	1.1016	0.500	0.241
01.1.307	Grey snapper	0.366	100.9	113.8	1.1286	0.413	0.200
01.1.308	Red snapper	0.259	100.9	113.1	1.1219	0.290	0.140
01.1.309	Sardines	0.851	117.7	188.3	1.5995	1.362	0.658
01.1.4	**Milk, Cheese & eggs**	**10.965**				**29.49**	**14.26**
01.1.401	Eggs	1.618	116.5	202.5	1.7376	2.811	1.359
01.1.402	Fresh milk	0.331	111.4	180.3	1.6177	0.535	0.259
01.1.404	Evaporated milk	0.445	105.8	223.9	2.1169	0.942	0.456
01.1.405	Powdered milk	6.348	101.5	282.9	2.7866	17.690	8.551
01.1.406	Cheese	2.223	105.7	357.3	3.3807	7.515	3.632

		Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	Col. 8
COICOP Code	**Item Name**	**Expenditure Share 2015**	**Avg. CPI 2015**	**CPI Dec. 2017**	**Update Factor**	**Updated Weight**	**Normalized Weight**
01.1.5	**Oils & Fats**	**5.573**				**8.31**	**4.02**
01.1.501	Butter, fresh	0.269	113.9	214.3	1.8807	0.506	0.245
01.1.503	Margarine	1.435	106.8	216.7	2.0282	2.911	1.407
01.1.504	Peanut butter	1.194	103.2	151.7	1.4699	1.755	0.848
01.1.506	Fry Oil/Vegetable Oil	2.674	120.6	141.6	1.1744	3.141	1.518
01.1.6	**Fruits**	**5.706**				**14.67**	**7.09**
01.1.601	Oranges	0.990	68.3	217.3	3.1830	3.152	1.523
…	…	…	…	…	…	…	…

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 item price indexes 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 item indexes already available for the CPI items that continue.

47. There is an issue, however, for deriving the update factors for the new items in the basket. As previously noted, NSOs will not have price data for the new items from 2015 nor will they have price indexes to use for calculating the weight update factors for the new items.[2] In some instances the NSO may have anticipated that certain items were becoming important and most likely would appear in the new basket. For these items, they may have collected prices or started test item indexes 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 indexes available in December 2017.

48. For the new items the NSO can identify, as mentioned earlier, existing items whose price trends might be reflective of the new items in the basket. Otherwise, the price index for the higher level class aggregate can be used. In Table 3, there are six new items and for each of these the NSO needs to select a representative 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, mangoes use the papaya index, bitter squash uses the squash index, and sweet potatoes use the white potato index. The only item for which the class index is used is corned beef.

49. For each item index in Table 3, the 2015 monthly indexes were averaged for the calendar year and appear in column 4.[3] The December 2017 indexes are in column 5. The update factors are calculated in column 6 as the December 2017 index (column 5) divided by the 2015 average index (column 4). Next, the 2015 weights (column 3) are multiplied by the update factors (column 6) to derive the updated weights (column 7). Finally, the updated weights are normalized (divided by the total of the updated weights in the first row of column 7 and converted to percentages) to sum to 100 (column 8).

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

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

[3] The calculations for updating the weights are only made for the item indexes where the new weights are applied. The class and higher level indexes will be calculated using the weights updated to December 2017 in the next section.

D. Introducing new weights

51. After the price reference date is determined and the decision on using the original weights or the price updated weights is made, 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 survey 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 turn.

Introduce new weights with the same weight and price reference periods—Laspeyres index

52. The NSO can use the weight reference period as the price reference period by resetting the base period of the elementary indexes to 100 in the weight reference period. In Table 4 the average price for 2015 (the weight reference period for the HES) is set to 100 (column 3) by dividing all the elementary indexes by their 2015 average and expressing them as an index. In columns 4, 5, and 6, the new weights are used to aggregate the rebased indexes to higher levels starting with the class levels. At the class level the new weights are applied to derive the group indexes and similarly for the division index.

53. The NSO must complete this aggregation for all months from January 2015 through January 2018. Table 4 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.

Table 4: Revised CPI with the Same Weight and Price Reference Periods

		Col. 3	Col. 4	Col. 5	Col. 6	Col. 7
COICOP Code	Item Name	Expenditure Share 2015	Avg. CPI 2015	CPI Dec. 2016	CPI Dec. 2017	CPI Jan. 2018
01	**Food and Nonalcoholic 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**	**223.1**	**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	157.0	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**

		Col. 3	Col. 4	Col. 5	Col. 6	Col. 7
COICOP Code	**Item Name**	**Expenditure Share 2015**	**Avg. CPI 2015**	**CPI Dec. 2016**	**CPI Dec. 2017**	**CPI Jan. 2018**
01.1.301	Grouper	1.822	100.0	173.5	247.0	249.5
01.1.302	Sea Trout	0.989	100.0	111.6	123.2	125.1
01.1.303	Salted fish	0.986	100.0	255.6	411.2	419.4
01.1.304	Butter fish	0.256	100.0	112.2	124.4	125.7
01.1.305	Shrimp, fresh	0.454	100.0	105.1	110.2	111.8
01.1.307	Grey snapper	0.366	100.0	106.4	112.9	115.1
01.1.308	Red snapper	0.259	100.0	106.1	112.2	113.3
01.1.309	Sardines	0.851	100.0	130.0	159.9	160.7
01.1.4	**Milk, Cheese & eggs**	**10.96**	**100.0**	**184.5**	**269.0**	**272.2**
01.1.401	Eggs	1.618	100.0	136.9	173.8	176.4
01.1.402	Fresh milk	0.331	100.0	130.9	161.8	163.4
01.1.404	Evaporated milk	0.445	100.0	155.8	211.7	215.9
01.1.405	Powdered milk	6.348	100.0	189.3	278.7	281.4
01.1.406	Cheese	2.223	100.0	219.0	338.1	343.1
01.1.5	**Oils & Fats**	**5.573**	**100.0**	**124.6**	**149.2**	**151.2**
01.1.501	Butter, fresh	0.269	100.0	144.0	188.1	189.9
01.1.503	Margarine	1.435	100.0	151.4	202.8	205.9
01.1.504	Peanut butter	1.194	100.0	123.5	147.0	149.9
01.1.506	Fry Oil/Vegetable Oil	2.674	100.0	108.7	117.4	118.6
01.1.6	**Fruits**	**5.71**	**100.0**	**178.6**	**257.2**	**260.7**
01.1.601	Oranges	0.990	100.0	209.1	318.3	323.1
…	…	…	…	…	…	…

Introduce the new weights directly in a new price reference period—Young Index

54. The second option is for the NSO to introduce the new weights directly in a new price reference period. As discussed in section I.C, 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.

55. Assume the NSO has decided to introduce the new weights directly in December 2017 to use in the compilation of the January 2018 index (columns 3–5 of Table 4). 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 4, col.3) are used directly with the elementary indexes to derive the higher level aggregates.

56. The new index starts with December 2017 = 100 as shown in column 4 of Table 4. The January 2018 elementary indexes appear in column 5. The 2015 CPI weights are used to aggregate the elementary indexes to the class, group, and division levels as discussed in the previous example. The aggregate index changes are different from those in the previous example because the weights reflect the fact that the expenditure shares are fixed at their 2015 levels, but not used in the index calculation until December 2017. In Table 4, the price change for Food and Nonalcoholic Beverages is 1.37 percent ([209.24 ÷ 206.41]* 100 – 100), compared to 1.36 percent (column 5) in Table 5.

Introduce the updated weights in a new price reference period—Lowe index

57. The third option is for the NSO to introduce the new weights updated for price change between 2015 and December 2017 (Table 3, Col.8) 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 indexes to derive the higher level aggregates.

58. Referring to Table 5, the revised index starts with December 2017 = 100 as shown in column 4. The price-updated weights from 2015 to December 2017 (col. 6) are used to aggregate the elementary indexes to the class, group, and division levels as discussed in the previous examples. The aggregate index changes are the same as those in Table 4 because the weights reflect the fact that the quantities (not expenditure) shares are fixed at their 2015 levels. In Table 5, the price change for Food and Nonalcoholic Beverages using the price-updated weights is 1.37 percent (column 7).

59. In the first approach (Table 3), the NSO estimated a Laspeyres index with the quantity shares fixed at 2015 levels and price reference period of 2015. The Laspeyres index requires that the price and weight reference periods are the same. In the third approach (Table 5, columns 6-7), 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 indexes 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 3. The aggregate price relative between 2015 and December 2017 is 2.06883 (206.883 ÷ 100). All items with price changes (update factors in column 6) greater than this value have larger final weights (column 8) when compared to the 2015 weights (column 3). The Young index produced in the second approach (Table 4) holds the expenditure shares fixed and allows for some substitution of quantities as prices change.

Table 5: Revised CPI with a New Price Reference Period

		Col. 3	Col. 4	Col. 5	Col. 6	Col. 7
COICOP Code	**Item Name**	**Expenditure Share 2015**	**CPI Dec. 2017**	**CPI Jan. 2018**	**Expenditure Share Dec 2017**	**CPI Jan. 2018**
01	**Food and Nonalcoholic 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**	**101.70**	**19.24**	**101.69**
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	101.50	0.885	101.50
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**
01.1.301	Grouper	1.822	100.0	101.00	2.175	101.00
01.1.302	Sea Trout	0.989	100.0	101.50	0.589	101.50
01.1.303	Salted fish	0.986	100.0	102.00	1.960	102.00
01.1.304	Butter fish	0.256	100.0	101.00	0.154	101.00

		Col. 3	Col. 4	Col. 5	Col. 6	Col. 7
COICOP Code	**Item Name**	**Expenditure Share 2015**	**CPI Dec. 2017**	**CPI Jan. 2018**	**Expenditure Share Dec 2017**	**CPI Jan. 2018**
01.1.305	Shrimp, fresh	0.454	100.0	101.50	0.241	101.50
01.1.307	Grey snapper	0.366	100.0	102.00	0.200	102.00
01.1.308	Red snapper	0.259	100.0	101.00	0.140	101.00
01.1.309	Sardines	0.851	100.0	100.50	0.658	100.50
01.1.4	**Milk, Cheese & eggs**	**10.96**	**100.0**	**101.22**	**14.26**	**101.21**
01.1.401	Eggs	1.618	100.0	101.50	1.359	101.50
01.1.402	Fresh milk	0.331	100.0	101.00	0.259	101.00
01.1.404	Evaporated milk	0.445	100.0	102.00	0.456	102.00
01.1.405	Powdered milk	6.348	100.0	101.00	8.551	101.00
01.1.406	Cheese	2.223	100.0	101.50	3.632	101.50
01.1.5	**Oils & Fats**	**5.573**	**100.0**	**101.34**	**4.018**	**101.39**
01.1.501	Butter, fresh	0.269	100.0	101.00	0.245	101.00
01.1.503	Margarine	1.435	100.0	101.50	1.407	101.50
01.1.504	Peanut butter	1.194	100.0	102.00	0.848	102.00
01.1.506	Fry Oil/Vegetable Oil	2.674	100.0	101.00	1.518	101.00
01.1.6	**Fruits**	**5.71**	**100.0**	**101.40**	**7.09**	**101.36**
01.1.601	Oranges	0.990	100.0	101.50	1.523	101.50
…	…	…	…	…	…	…
…	…	…	…	…	…	…

E. Decide on the index reference period

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 HES weight reference period of the 2015 annual average as the weight, price, and index reference periods. In the second example, a new price and index reference period was established for December 2017 with the weight reference period of 2015. 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.

61. Most NSOs change the index reference period to correspond to the price reference period. Often this is the case in developing countries because CPI revisions have historically occurred on a ten-year cycle or longer. The shift in the 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.

62. If the NSO chooses to keep the old reference period, users may not notice that the CPI has been revised. Most users are concerned with the overall total CPI and perhaps some of the major division indexes. They do not necessarily use any of the detailed indexes 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 due to new products entering, old products leaving, and, perhaps, an updated classification system. However, maintaining the old reference period is probably helpful to the large majority of users whose only interest is to monitor changes in the overall CPI.

63. If the NSO decides to change the index reference period, they should link the old series 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, they must link the new series to the old series which

will provide a continuous series. Linking techniques to form a time series for the CPI are presented in Section III.

F. Formula used for estimation

Elementary aggregate indexes

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 straight forward 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 base (price reference) period or the average of the long-term price relative for each observation from the base period to the current period.

65. In using the short-term relative approach, the elementary aggregate index for the period is derived as either the ratio of average prices in the current period to the average prices in the previous period or the average of the short-term price relatives for each observation from the previous period to the current period.

66. These two short-term methods require a different weight structure than the long-term method to derive the aggregate short-term price relative. In the long-term method the weights from the base period are used to aggregate the item *indexes* to derive the higher-level *indexes*. In the short-term method, the item weights are updated each period using the short-term price relatives for the elementary aggregates, and the updated weights from the previous period (often referred to as cost weights[4]) are used to aggregate item *price relatives* for the current period to derive the higher-level *price relatives*. The indexes at the elementary and higher levels are derived by multiplying the previous period index by the price relative for the current period.

67. In Chapter 9 (Vol.1) and Chapter 20 (V0l. 2), strongly urges the NSOs to use geometric averages of prices and price relatives rather than arithmetic averages whenever weights are not available. It identifies several problems with the arithmetic formulas that are less problematic when using geometric averages.

Higher level aggregate indexes

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

69. 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 (base) in the previous period. Therefore, the aggregation weights must refer to the previous period. A good rule to remember is that when calculating price

[4] In general, cost weights are the item weight x the item index. It represents what item's share of the basket would be at current prices. They can be calculated directly by taking the weight in the index reference times the current period index or they can be calculated by chaining together the short term relatives from the price reference times the item weight in the price reference period.

movements, the price period in the denominator of the index formula should be the same as the price period implicit in the weights.

70. The weight required is one that reflects the 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.

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

72. When the CPI is revised and the NSO introduces a new market 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 provide 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 = 100.0 will have registered price changes over the period from 2012 to the end of December 20017. The new series with 2017 = 100.0 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 below.

III. LINKING THE PREVIOUS CPI TO THE NEW PRICE INDEX REFERENCE BASE

73. The NSO may choose to start the new series using the new price reference period. In Chapter 4 the recommendation is that when a new index is introduced there should be an overlap period for the two indexes 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.

A. Single month (or quarter)

74. At minimum, a single common period is required as an overlap period between the indexes. This is not the preferred method. An annual overlap is preferred.[5] 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. Section V provides a detailed discussion on annual weight updates.

[5] A single year is preferred as the price reference period for infrequently rebased CPIs. When 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 (and resultant indexes) may have to be used for the price reference and linking period. Further, if a single unusual month is to act as the index reference period (=100) the initial impression of the index change may be a distorted one. Preferable is that the overlap period for linking is a whole year in which seasonal prices would be appropriately represented. In some months there will be no sales of seasonal fruits, but an average price for the whole year would still be available for the price reference period.

75. Although not a preferred method, some NSOs will update their weights using a single period overlap which is presented here as an example of the linking process. Assume December 2017 is the link period an 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 should be produced for December 2017. If that is the case, the linking of the series is straight forward. In December 2017 each of the new CPI indexes 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 indexes' levels to those of the new index. Since the new indexes all have a value of 100 and the NSO wants the old indexes to have that same value, the NSO can simply reference the old series to 100 by dividing each item, 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).

76. Table 6 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 Nonalcoholic Beverages), a Group (Food), two classes (Bread & Cereals and Meat), and 12 items. Column 4 contains the old CPI in the overlap moth (December 2017) and column 5 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 6. 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, and Item.

77. 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 7) are simply the ratios of the old index levels (column 4) to the price reference index levels (column 5).

Table 6: Linking CPI Series using a Single Period Overlap on a New Index Reference Period

		Col. 3	**Col. 4**	**Col. 5**	**Col. 6**	**Col. 7**
COICOP Code	**Item Name**	**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)**
					Col. 5 / 4	**Col. 4 / 5**
01	**Food and Nonalcoholic Bev.**	**100.00**	**119.88**	**100.00**	**0.834137**	**1.198845**
01.1	**FOOD**	**94.83**	**119.80**	**100.00**	**0.834729**	**1.197993**
01.1.1	**Bread & Cereals**	**22.41**	**132.49**	**100.00**	**0.754752**	**1.324939**
01.1.101	Rice (white)	5.759	150.7	100.0	0.663569	1.507003
01.1.102	Rice (Brown)	0.381	151.7	100.0	0.659069	1.517291
01.1.103	Flour	4.356	134.8	100.0	0.741618	1.348404
01.1.104	Bread	6.167	127.2	100.0	0.786264	1.271837
01.1.105	Biscuits (Salted)	1.083	113.0	100.0	0.884583	1.130477
01.1.106	Cakes, Pastry, etc.	0.375	131.2	100.0	0.762150	1.312077
01.1.107	Chow Mein	1.370	125.1	100.0	0.799156	1.251320
01.1.109	Macaroni	0.426	105.8	100.0	0.944739	1.058493
01.1.110	Oat flakes	0.751	100.6	100.0	0.994472	1.005558

01.1.111	Sago	0.535	103.5	100.0	0.966429	1.034738
01.1.112	Tennis Rolls	0.589	126.0	100.0	0.793756	1.259832
01.1.113	***Whole Wheat Bread****	0.622	***127.2***	***100.0***	***0.786264***	***1.271837***
01.1.2	**Meat**	**17.358**	**111.87**	**100.00**	**0.893923**	**1.118665**

B. Yearly average

78. Most NSOs will establish a new price reference period using an annual average from a previous year. The simplest and easiest method for users 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 7: Linking Old and New Index Series to a Previous Annual Average

		Col. 2	Col. 3	Col. 4	Col. 5	Col 6	Col. 7
		CPI (2012=100)	Forward Link	CPI (2017=100)	Backward Link	12-month % change	
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

79. Table 7 shows the method for linking a new series to the old using a 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 indexes 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 2. 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 indexes by the 2017 annual average which appears in Col. 3. The link month index for the old series is December 2017. 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 2). The backward linking factor is in column 4 and the backward linked series is in column 5. (Note that column 5 is identical to the series in column 3.)

Step 2: The indexes for the new series are compiled for all months of 2017 using the new weights and price reference period. These appear in column 4 of Table 7.

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. From the example, all the indexes for December 2017 in the new series will be set to the index levels of the re-referenced old series in column 3. 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. 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. In the example, the old series link month index is n column 3 and the new series link month index is in column 4. The forward linking factor appears in column 3.

80. 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 indexes to use for the annual inflation rates. The old series will have inflation rates calculated through the link month. In Table 7 column 6 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 4) that appear in column 6.

81. The NSO, however, may decide to publish the new CPI series for the overlap year in which case the data for 2017 in column 4 would be published. Because this will be treated as the revised CPI series, the annual inflation rates should be recalculated for 2017 using the revised series as should the inflation rates for the months of 2018 shown in column 7.

C. Keeping the old index reference period

82. 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 2 of Table 8 would be applied to the new index level in column 4 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 indexes' reference period (2017=100) expressed as a price relative (column 2). 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 base period is not published, the annual rates of change in column 6 are all calculated using the published series with 2012=100. If the short-term relative compilation method used, each index is starts with its level in December 2017.

Table 8: Linking new series to an old index reference period

		Col. 2	Col. 3	Col. 4	Col. 5	Col. 6
		CPI (2012=100)	Forward Link	CPI (2017=100)	Backward Link	12-month % change
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		2.8
	Mar	128.4	128.6	98.8		2.8
	Apr	129.4	129.6	99.6		3.2
	May	129.6	129.9	99.8		3.2
	Jun	130.2	130.3	100.1		3.0
	Jul	130.6	130.5	100.3		3.2
	Aug	131.5	131.0	100.7		3.4
	Sep	131.5	131.3	100.9		3.6
	Oct	131.4	131.6	101.1		3.4
	Nov	131.4	131.3	100.9		2.7
	Dec	131.4	131.2	100.8		2.8
	AVG	**130.133**	**130.133**	**100.000**		**3.2**
Link	**Factors**	**1.301333**		**0.768443**		
2018	Jan		132.3	101.7		3.2
	Feb		132.6	101.9		3.5
	Mar		132.3	101.7		2.9
	Apr		132.7	102.0		2.4
	May		132.7	102.0		2.2

Jun		133.5	102.6		2.5
Jul		133.8	102.8		2.5
Aug		133.8	102.8		2.1
Sep		134.3	103.2		2.3
Oct		134.6	103.4		2.3
Nov		134.7	103.5		2.6
Dec		136.0	104.5		3.7

D. Example of calculating new series at the first level of aggregation

83. 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 the item-level CPI series starting with the first pricing period in 2017. Assuming the CPI series is monthly, each monthly item index (first level of aggregation) in 2017 must be divided by the 2017 annual average to re-reference the indexes to 2017=100. The re-referenced item indexes are aggregated using the new weights to derive the higher-level indexes. 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 indexes adjusted to the 2012 index reference period will be different because the new weights have changed the levels of the monthly indexes.

84. The example in the first box of Table 9 shows the monthly item and class indexes for Oils and Fats in 2017 on the old reference period (2012=100). It also has the annual averages[6] for 2017 and the re-referenced monthly indexes for the class index in column 8 (i.e., dividing the monthly class indexes by the annual average of 111.8).

85. In the second box of Table 8 the monthly item indexes for the four items in the class are re-referenced to 2017 = 100 and these indexes are aggregated (columns 2-6) to the class level (column 7) using the new weights for 2017. Note that the new class indexes with 2017=100 in column 7 of the second box are different from those in column 8 of the first box. The reason for this is that the higher-level indexes are compiled using different weights and index levels than those in the old CPI.

86. The class indexes in column 7 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 indexes beginning in January 2018 would be linked to the December 2017 index level in column 7 as shown in Table 7. 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 8, 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 indexes in column 7 of the second box to tie them to the old index levels that appear in column 8. Note that these values are different from the values in column 7 of the first box, again due to the fact that the new indexes are compiled using different weights and index levels than those in the old CPI.

Table 9: Aggregating new CPI Series using an Annual Period Overlap

	Col. 2	Col. 3	Col .5	Col. 6	Col. 7	Col. 8	Col. 9

[6] Standard international practice for calculating annual average indexes is to use a simple arithmetic average of the monthly indexes. While geometric averaging could be used, the results can be different when aggregate indexes 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.

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 indexes using rebased series
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 indexes	(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**

E. Aggregation across linked series

87. When the new series is introduced there is a break in the comparability of the historical indexes. The new and previous series are no longer strictly comparable due to the change in weights, item structures, and, in the case of re-referencing the indexes, the level of the indexes. Each old series is re-referenced to the new base period. The re-referenced series will no longer yield the same results as before the rebasing when aggregated. This is demonstrated in column 9 of Table 9. In the first box of column 9 the new CPI series for the item indexes are aggregated using the old item weights. There differences between the rebased old series (column 7) and the re-aggregated new series using old weights (column 9) in April, May, September, and December demonstrating the effects of the weight differences. In the second box of Table 9, column 9, the old item indexes 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.

IV. FREQUENCY OF WEIGHT UPDATES

A. Data sources for more frequent weight updates

88. The primary source for more frequent updating of the CPI would be the HES. Countries that have a continuous HES conducted every quarter or every year can use the data from the HES to verify any significant shifts in the CPI basket and the weights. The NSO can develop a concordance between the HES 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 2, paragraph 2.54):

> "Each year it is desirable to carry out a review of the weights in order to ensure that they are sufficiently reliable and representative. The review, which may be confined to weights at the level of sub-indices and their major components, should examine whether or not there are indications that important changes may have taken place in the consumption pattern since the weighting reference period."

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

90. If HESs are conducted on a two- or three-year cycle, the NSO should give serious consideration to updating the weights as the latest HES results become available. In fact, many countries update their CPI weights on an annual or biannual basis in an attempt to minimize the substitution bias that is problematic with fixed-base indexes. Such frequent chaining keeps the CPI basket more representative of consumer purchases.

91. As discussed in Chapter 2, other sources for more frequent updating are the national accounts where data on household consumption expenditures are often available on an annual basis. A retail sales survey could also provide indications of changes in purchasing patterns for goods sold at retail outlets.

92. The shortcoming of these two sources is that they do not have the detail that is found in the HES. Typically, these sources may have data at the COICOP class level or group level. 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 or group 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".

93. Table 10 presents an example of partial weight updates. Assume that the NSO was able to use data from the national accounts and retail sales data to derive a new weight distribution at the class level. Col. 4 contains the NSO derived share weights at the class level. The weights at the item level are not available so the NSO 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. Col, 5 contains the item allocation share for each class. These are calculated by taking the 2015 expenditure shares for each item (Col. 3) and dividing it by the class share (Col. 3). The item allocation share in Col. 5 for each item is multiplied by the new class share to derive the updated item shares in Col. 6. The NSO can use these updated shares in the CPI to revise the weights.

94. 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 due to price change but the quantities have remained the same. It is consistent with a Lowe index. Column 7 contains the item allocation share for each class using the updated weights. These are calculated by taking the 2017 cost weights for each item (not shown in Table 10) and

dividing it by the class cost weight for 2017. The item allocation share in Col. 7 for each item is multiplied by the new class share to derive the updated item shares in Col. 8. The NSO can use these updated shares based on the 2017 cost weights in the CPI to revise the weights.

95. 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 Section II. The resulting revised indexes should be linked to the previous series using the methods described in Section III.

Table 10: Partial Weight Updates at the COICOP Class Level

		Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	Col. 8
COICOP Code	**Item Name**	**Expenditure Share 2015**	**High-Level Shares 2017**	**Allocation with 2015 Shares**	**Updated Shares 2017 base**	**Allocation with updated 2015 Shares**	**Updated Shares 2017 base**
01	**Food and Nonalcoholic 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**
01.1.301	Grouper	1.822		0.30452	2.040	0.35554	2.382
01.1.302	Sea Trout	0.989		0.16525	1.107	0.09626	0.645
01.1.303	Salted fish	0.986		0.16485	1.105	0.32039	2.147
01.1.304	Butter fish	0.256		0.04275	0.286	0.02514	0.168
01.1.305	Shrimp, fresh	0.454		0.07581	0.508	0.03947	0.264
01.1.307	Grey snapper	0.366		0.06118	0.410	0.03264	0.219
01.1.308	Red snapper	0.259		0.04328	0.290	0.02295	0.154
01.1.309	Sardines	0.851		0.14234	0.954	0.10761	0.721
01.1.4	**Milk, Cheese & eggs**	**10.96**	**10.40**		**10.40**		**10.40**
01.1.401	Eggs	1.618		0.14756	1.535	0.09532	0.991
01.1.402	Fresh milk	0.331		0.03016	0.314	0.01814	0.189
01.1.404	Evaporated milk	0.445		0.04060	0.422	0.03195	0.332
01.1.405	Powdered milk	6.348		0.57895	6.021	0.59979	6.238
01.1.406	Cheese	2.223		0.20272	2.108	0.25479	2.650

		Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	Col. 8
COICOP Code	**Item Name**	**Expenditure Share 2015**	**High-Level Shares 2017**	**Allocation with 2015 Shares**	**Updated Shares 2017 base**	**Allocation with updated 2015 Shares**	**Updated Shares 2017 base**
01.1.5	**Oils & Fats**	**5.573**	**4.60**		**4.60**		**4.60**
01.1.501	Butter, fresh	0.269		0.04832	0.222	0.06092	0.280
01.1.503	Margarine	1.435		0.25757	1.185	0.35019	1.611
01.1.504	Peanut butter	1.194		0.21425	0.986	0.21111	0.971
01.1.506	Fry Oil/Vegetable Oil	2.674		0.47986	2.207	0.37778	1.738
01.1.6	**Fruits**	**5.71**	**6.30**		**6.30**		**6.30**
01.1.601	Oranges	0.990		0.17353	1.093	0.21477	1.353
01.1.602	Pineapple	0.731		0.12812	0.807	0.11754	0.740
01.1.603	Bananas	1.370		0.24006	1.512	0.28088	1.770
01.1.605	Coconut-dry	0.317		0.05558	0.350	0.04888	0.308
01.1.606	Water melon	0.555		0.09724	0.613	0.12039	0.758
01.1.607	Apple	0.207		0.03636	0.229	0.03363	0.212
01.1.608	Cherry	0.257		0.04499	0.283	0.04831	0.304
01.1.609	Grapes	0.178		0.03112	0.196	0.02161	0.136
01.1.610	Limes	0.480		0.08415	0.530	0.06490	0.409
01.1.611	Papaya	0.176		0.03089	0.195	0.01393	0.088
01.1.612	***Mango****	0.445		0.07796	0.491	0.03517	0.222
01.1.7	**Vegetables**	**17.55**	**18.10**		**18.10**		**18.10**
01.1.701	Black-eyed peas	1.236		0.07046	1.275	0.05580	1.010
01.1.702	Split peas	0.575		0.03278	0.593	0.03051	0.552
01.1.703	Turnip greens	0.855		0.04873	0.882	0.03969	0.718
01.1.704	Red beans	0.593		0.03379	0.612	0.03577	0.647
01.1.705	Garlic	0.853		0.04861	0.880	0.03166	0.573
01.1.706	Onion	0.664		0.03785	0.685	0.01397	0.253
01.1.707	Egg plant	0.888		0.05063	0.916	0.02587	0.468
01.1.708	Spinach	1.058		0.06028	1.091	0.09881	1.788
01.1.709	Shallot	0.506		0.02881	0.521	0.04585	0.830
01.1.710	Ochre	0.694		0.03956	0.716	0.03160	0.572
01.1.711	Pumpkin	0.809		0.04608	0.834	0.02933	0.531
01.1.712	Tomatoes	0.771		0.04395	0.795	0.05095	0.922
01.1.713	Squash	0.339		0.01932	0.350	0.00495	0.090
01.1.714	Plantains	1.337		0.07617	1.379	0.08113	1.468
01.1.715	Long beans	1.143		0.06514	1.179	0.12334	2.232
01.1.716	Cabbage	0.828		0.04718	0.854	0.04811	0.871
01.1.717	Carrots	0.838		0.04778	0.865	0.07173	1.298
01.1.718	Cucumber	0.324		0.01846	0.334	0.01672	0.303
01.1.719	Cassava	0.474		0.02702	0.489	0.03336	0.604
01.1.720	Eddoes	0.678		0.03865	0.700	0.05522	0.999
01.1.721	White potatoes	1.541		0.08780	1.589	0.06129	1.109
01.1.722	***Bitter squash****	0.288		0.01643	0.297	0.00421	0.076
01.1.723	***Sweet Potatoes****	0.255		0.01452	0.263	0.01013	0.183
01.1.8	**Sugar, Jam, Honey, Chocolate &**	**3.84**	**3.30**		**3.30**		**3.30**
01.1.801	Sugar (dark)	2.569		0.66908	2.208	0.70957	2.342
01.1.802	Sweets	0.163		0.04245	0.140	0.04125	0.136
01.1.803	Chocolates	0.333		0.08684	0.287	0.06586	0.217
01.1.804	Ice cream	0.774		0.20163	0.665	0.18331	0.605
01.1.9	**Food Products N. E. C**	**4.64**	**4.10**		**4.10**		**4.10**
01.1.901	Baby food (mainly milk)	0.634		0.13653	0.560	0.13371	0.548
01.1.904	Salt	0.230		0.04944	0.203	0.04918	0.202
01.1.903	Curry powder	0.584		0.12572	0.515	0.15301	0.627
01.1.910	Black pepper	0.307		0.06619	0.271	0.08456	0.347
01.1.911	Masala	0.258		0.05551	0.228	0.02214	0.091
01.1.902	Tomato paste	0.673		0.14503	0.595	0.14016	0.575
01.1.908	Vinegar	0.443		0.09545	0.391	0.11326	0.464

		Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	Col. 8
COICOP Code	**Item Name**	**Expenditure Share 2015**	**High-Level Shares 2017**	**Allocation with 2015 Shares**	**Updated Shares 2017 base**	**Allocation with updated 2015 Shares**	**Updated Shares 2017 base**
01.1.906	Celery	0.497		0.10700	0.439	0.03622	0.148
01.1.905	Red pepper	0.192		0.04140	0.170	0.03182	0.130
01.1.909	Baking powder (prepd.)	0.189		0.04081	0.167	0.04843	0.199
01.1.907	Ketchup	0.636		0.13691	0.561	0.18753	0.769
1.2	**NON - ALCOHOLIC BEVERAGES**	**6.69**	**8.10**		**8.10**		**8.10**
01.2.1	**Coffee, Tea & Cocoa**	**2.72**	**3.60**		**3.60**		**3.60**
01.2.102	Coffee - extract	0.507		0.18628	0.671	0.21150	0.761
01.2.103	Tea	0.740		0.27198	0.979	0.29438	1.060
01.2.104	Milo	1.102		0.40490	1.458	0.38420	1.383
01.2.105	Ovaltine	0.372		0.13684	0.493	0.10991	0.396
01.2.2	**Mineral Waters, Soft Drinks, Fruit**	**3.97**	**4.50**		**4.50**		**4.50**
01.2.202	Malt	0.366		0.09209	0.414	0.13525	0.609
01.2.203	Soft drink	3.428		0.86272	3.882	0.78861	3.549
01.2.204	Purified Water/Bottled	0.180		0.04519	0.203	0.07614	0.343

V. ANNUAL UPDATING AND LINKING

96. 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 10 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 Section III.A.

97. Assume the NSO decides to introduce the new weights in January 2018. If the annual 2015 weights and price reference period are used, the indexes need to be recompiled from January 2015 to December 2017. The NSO would then revise the indexes for the three year period 2015 – 2017. Most countries have policies of no revisions to the CPI, and this approach is not often used.

98. 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.[7] 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 4 and 5 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.

99. If this linking process continues for multiple years, the linking factors for each year must be derived from the indexes 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

[7] 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.

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, 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 indexes 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.[8]

Table 11: Linking Annual Indexes for Multiple Periods with Chained Linking Factors

		Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	Col. 8	Col. 9	Col. 10
COICOP Code	Item Name	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
01	Food and Nonalcoholic 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

[8] 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 indexes.

100. Table 11 demonstrates the process for linking annual indexes for multiple periods. The new index reference period in January 2015 was Dec. 2014 = 100 (Col. 3). The NSO proceeded to update the weights in January 2016, January 2017, and January 2018, while maintaining the original index reference period of Dec. 2014. In January 2015, new weights were introduced from 2013 and new price and index reference periods were set to December 2014 = 100. This is also the overlap month so the indexes are converted to long-term relatives and serve as the linking factors (Col. 5) to tie to the next year's indexes. In January 2016 weights were introduced from 2014 and new price and index reference periods were set to December 2015 = 100. The link factors from the previous year (Col. 5) are applied to the new index levels for December 2015 (column 6) to derive the current year index levels (Col. 7) with Dec. 2015 = 100. These indexes are then converted to linking factors to use with the 2016 indexes (Col. 8). 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 (Col. 8) were applied to the December 2017 index (column 9) to derive the index for December 2017 with Dec. 2014 =100 (Col. 10).

101. The index levels in Cols. 6 and 9 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 10, the chaining of the linking factors is similar to chaining the annual indexes of the three year period (December 2014 to December 2016). For example, the December 2017 index for the Food Group of 123.71 is the product of chaining the price changes (indexes converted to price relatives) for the three years (1.089085 × 1.0629 × 1.0687) to the December 2014 reference period index of 100.

Biannual updating

102. The NSO may not have data on an annual basis to update the weights. The frequency of the updating generally is in line with the availability of source data to derive more current weights. Whether the update period is once a year, every two years, or longer, the NSO will use the same processes as those presented above to complete the job. The NSO has to decide on what the price reference period should be and whether to change the index reference period with each update. After those decisions are made, one of the approaches discussed in Sections III or IV should be used.

VI. INTRODUCING NEW CLASSIFICATION SYSTEMS

103. Chapter 2 recommends that countries adopt the United Nations' Classification of Individual Consumption by Purpose (COICOP). Many countries that have been using a national commodity classification system will want to introduce the COICOP at the time of their next CPI revision in order to meet the *Manual* recommendations. The introduction of COICOP may cause a break with the old classification system. For example, the COICOP classifies household consumption expenditures into 12 Divisions as shown in the Appendix. 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 Hotels, while the national classification may include these in Division 01, Food and Beverages.

104. 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 indexes. Some Divisions may be the same such as Clothing and Footwear and Health. Others will have differences in the detailed components such Furnishings, Household Equipment, and Routine Household Maintenance (where televisions and video equipment are

moved to Entertainment) or be broken out into other components such as Transport and Communications being separated into two Divisions.

105. In most instances the old CPI includes the same detailed components as the COICOP, but the components appear in different divisions. It is 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 12 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 indexes 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.

106. Alternatively, if the NSO decides to keep the 2010 =100 reference period, the changes in the revised CPI can be applied to 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 20100.

107. 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 MP3 players and other audio media. In addition, electronic items such as digital video recorders may be added. In some instances, owner-occupied housing may now be represented whereas only rental units were included previously.

108. 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 5-10 years, the NSO needs to make extra efforts to insure that users are aware of changes and discontinuities in series.

VII. EXPANDING CPI GEOGRAPHIC COVERAGE

109. Many countries have CPIs with limited geographic coverage—capitol city, two or three of the largest areas, large and medium size 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 HES so that representative market baskets can be developed for

more geographic areas.[9] 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 indexes to the previous measures needs to be done with caution and users advised about the differences in coverage.

110. Often NSOs may first produce a CPI for the capitol city 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 capitol city and for the new areas. In such a case, the capitol city index for the revised CPI can be linked to the previous capitol city index with meaningful results in that the geographic coverage has not changed even though the structure of consumer spending patterns may differ.

111. 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 market 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 capitol city may have substantially more weight for housing, clothing, and education and substantially less for food and transport than the new areas), then 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.

112. 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 market 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 indexes were also produced, those with the same geographic coverage could be linked to form a time series.

113. 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. If some users want a linked series, they can compile it themselves.

VIII. SUMMARY AND CONCLUSION

114. The CPI is one of the most watched indicators of economic performance in modern economies. It is used by policy makers in government, business, and private institutions to gauge the general movement of prices and determine the presence of inflationary conditions. Because of the CPI's importance, it is critical to users that it remains both accurate and relevant. The agencies producing the CPI should revise the market

[9] In some cases the expansion may take place by using an existing basket such as that for the capitol 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.

basket, update the CPI weights, and link the revised CPI to the previous series to form a time series. The latter is needed by policy makers and other users for inflation analysis and escalation of payments.

115. Once weights are derived an important step is to decide which formula to use for higher-level (weighted) aggregation of price changes. Many countries price-update their weights from the survey period to the price reference period in order to preserve a concept of a fixed quantity basket index, albeit with quantities fixed in the expenditure survey period. Such an index is a Lowe index, to be contrasted with an index that is simply a survey period expenditure-share weighted average of price changes, a Young index. The implementation of a Young index is quite straightforward, as a weighted average of price changes, and attention here is focused on the steps involved in price-updating the weights to derive a Lowe index, along with the decision as to whether or not to price-update.

116. This chapter provides guidance to those responsible for the CPI on the various steps, methods, and procedures for linking the revised CPI with the previous CPI to form an analytical historical series. It is important that the agencies compiling the CPI conduct frequent surveys to measure household spending patterns so that these data can be used to revise the CPI basket on a regular basis. International best practice dictates that the CPI weights should be updated at least once every five years (more frequently if the pattern of consumer spending changes rapidly) and that the revised CPI be linked to the previous CPI to provide users with a continuous series. In fact, many countries now update the weights on an annual or biannual basis and link the series at the time of the update.

117. Source surveys such as the HES may not be available on an annual basis, but data from the national accounts on household final consumption expenditures or retails sales can provide current estimates of household spending at aggregate levels to use in completing partial updates the CPI weights at aggregate levels. In such a case, the NSO can do interim partial updates to the CPI weights until the more detailed weights become available.

118.

Appendix 1: Estimation of Elasticity of Substitution with Linear Regression

The NSO can estimate η using the regression approach by taking the following steps:

i. Calculate the natural logarithm (ln) of the item shares present in both 2015 (ln 2015 shares) and 2010 (ln 2010 shares). There are 90 in this example.
ii. Subtract the 2010 natural log from the 2015 natural log (**Δ ln of Shares)**.
iii. Convert the price indexes to price relatives by dividing by 100.
iv. Calculate the natural log of the price relatives (**ln Price Rel**).
v. Calculate the weights for each observation as **Δ Share / Δ ln of Shares.**
vi. Sum the column of weights.
vii. Calculate normalized **Weights** (i.e., weights that sum to 1.0 by dividing by the sum of the weights in the previous step).
viii. Calculate a weighted linear regression with the **Δ ln of Shares** as the left hand variable and **ln Price Rel** and **Weights** as the right hand variables.
The calculations formulas appear below following the table.
These should work if there is no missing data. With missing data, the NSO must insure that the averages do not include unmatched data.

COICOP Code	Item Name	Expenditure Share 2010	Expenditure Share 2015	Avg. CPI 2015/100	ΔShare	ln Share 2010	ln Share 2015	Δln of Share	ln PriceRel	Initial Weights	Weights
		Original Data		Step iii		Step i	Step i	Step ii	Step iv	Step v&vi	Step vii
01.1.101	Rice (white)	5.759	1.406	1.5070	-4.352	1.7508	0.3411	-1.4097	0.4101	3.0876	0.0322
01.1.102	Rice (Brown)	0.381	3.361	1.5173	2.981	-0.9661	1.2123	2.1784	0.4169	1.3682	0.0143
01.1.103	Flour	4.356	2.578	1.3484	-1.778	1.4716	0.9470	-0.5245	0.2989	3.3896	0.0354
01.1.104	Bread	6.167	6.864	1.2718	0.697	1.8193	1.9263	0.1071	0.2405	6.5097	0.0679
01.1.105	Biscuits (Salted)	1.083	0.813	1.1305	-0.270	0.0800	-0.2071	-0.2871	0.1226	0.9416	0.0098
01.1.106	Cakes, Pastry, etc.	0.375	1.034	1.3121	0.659	-0.9796	0.0338	1.0133	0.2716	0.6502	0.0068
01.1.107	Chow Mein	1.370	1.716	1.2513	0.346	0.3148	0.5397	0.2249	0.2242	1.5363	0.0160
01.1.109	Macaroni	0.426	1.284	1.0585	0.857	-0.8528	0.2496	1.1025	0.0568	0.7777	0.0081
01.1.110	Oat flakes	0.751	0.450	1.0056	-0.301	-0.2864	-0.7987	-0.5122	0.0055	0.5876	0.0061
01.1.111	Sago	0.535	0.341	1.0347	-0.194	-0.6249	-1.0761	-0.4512	0.0341	0.4308	0.0045
01.1.112	Tennis Rolls	0.589	1.392	1.2598	0.803	-0.5300	0.3307	0.8607	0.2310	0.9333	0.0097
01.1.113	Whole Wheat Bread*	0.622	0.180	1.2718	-0.442	-0.4755	-1.7150	-1.2394	0.2405	0.3563	0.0037
01.1.201	Stew Beef	4.499	1.940	1.1052	-2.559	1.5039	0.6628	-0.8411	0.1000	3.0425	0.0317
01.1.205	Chicken (live)	1.577	1.038	1.1258	-0.539	0.4553	0.0369	-0.4184	0.1185	1.2884	0.0134
01.1.206	Chicken (frozen)	8.904	10.202	1.1023	1.298	2.1865	2.3226	0.1361	0.0974	9.5386	0.0995
01.1.207	Pork Leg	0.473	0.610	1.3878	0.136	-0.7480	-0.4951	0.2530	0.3277	0.5385	0.0056
01.1.211	Duck	0.291	0.217	1.0730	-0.074	-1.2350	-1.5268	-0.2917	0.0705	0.2522	0.0026
01.1.212	Liver	0.245	0.207	1.1544	-0.038	-1.4057	-1.5754	-0.1697	0.1436	0.2255	0.0024
01.1.213	Mutton	0.319	0.271	1.0680	-0.048	-1.1415	-1.3060	-0.1645	0.0658	0.2944	0.0031
01.1.214	Sausages (pork & chicken)	1.049	1.823	1.2027	0.774	0.0481	0.6005	0.5524	0.1846	1.4007	0.0146
01.1.301	Grouper	1.142	1.822	0.9454	0.679	0.1329	0.5997	0.4668	-0.0561	1.4555	0.0152

COICOP Code	Item Name	Expenditure Share 2010	Expenditure Share 2015	Avg. CPI 2015/100	ΔShare	ln Share 2010	ln Share 2015	Δln of Share	ln PriceRel	Initial Weights	Weights
		Original Data		Step iii		Step i	Step i	Step ii	Step iv	Step v&vi	Step vii
01.1.302	Sea Trout	0.785	0.989	1.0978	0.203	-0.2416	-0.0115	0.2300	0.0933	0.8831	0.0092
01.1.303	Salted fish	0.431	0.986	1.1624	0.555	-0.8407	-0.0140	0.8267	0.1505	0.6710	0.0070
01.1.304	Butter fish	0.503	0.256	0.9882	-0.248	-0.6865	-1.3637	-0.6771	-0.0119	0.3657	0.0038
01.1.305	Shrimp, fresh	0.426	0.454	1.4015	0.028	-0.8536	-0.7907	0.0629	0.3375	0.4396	0.0046
01.1.307	Grey snapper	0.581	0.366	1.0085	-0.215	-0.5434	-1.0051	-0.4617	0.0085	0.4651	0.0049
01.1.308	Red snapper	0.393	0.259	1.0085	-0.134	-0.9347	-1.3513	-0.4165	0.0085	0.3212	0.0034
01.1.309	Sardines	0.221	0.851	1.1772	0.630	-1.5085	-0.1608	1.3477	0.1631	0.4676	0.0049
01.1.401	Eggs	2.442	1.618	1.1654	-0.824	0.8926	0.4812	-0.4114	0.1530	2.0016	0.0209
01.1.402	Fresh milk	1.209	0.331	1.1143	-0.878	0.1898	-1.1064	-1.2962	0.1082	0.6775	0.0071
01.1.404	Evaporated milk	0.622	0.445	1.0578	-0.176	-0.4756	-0.8093	-0.3337	0.0562	0.5285	0.0055
01.1.405	Powdered milk	6.603	6.348	1.0152	-0.255	1.8876	1.8482	-0.0394	0.0150	6.4749	0.0675
01.1.406	Cheese	2.507	2.223	1.0570	-0.284	0.9191	0.7988	-0.1203	0.0554	2.3621	0.0246
01.1.501	Butter, fresh	0.307	0.269	1.1394	-0.038	-1.1813	-1.3120	-0.1308	0.1305	0.2877	0.0030
01.1.503	Margarine	2.669	1.435	1.0683	-1.233	0.9816	0.3614	-0.6202	0.0661	1.9887	0.0207
01.1.504	Peanut butter	1.155	1.194	1.0318	0.039	0.1444	0.1772	0.0328	0.0313	1.1745	0.0123
01.1.506	Fry Oil/Vegetable Oil	2.600	2.674	1.2056	0.075	0.9553	0.9836	0.0283	0.1870	2.6367	0.0275
01.1.601	Oranges	1.398	0.990	0.6827	-0.408	0.3350	-0.0099	-0.3448	-0.3817	1.1823	0.0123
01.1.602	Pineapple	0.304	0.731	1.7028	0.427	-1.1893	-0.3132	0.8761	0.5323	0.4870	0.0051
01.1.603	Bananas	1.284	1.370	1.3547	0.086	0.2498	0.3147	0.0649	0.3036	1.3263	0.0138
01.1.605	Coconut-dry	0.180	0.317	1.0853	0.137	-1.7141	-1.1484	0.5657	0.0818	0.2422	0.0025
01.1.606	Water melon	0.644	0.555	1.1246	-0.090	-0.4394	-0.5890	-0.1496	0.1174	0.5985	0.0062
01.1.607	Apple	0.195	0.207	1.4572	0.012	-1.6330	-1.5727	0.0602	0.3765	0.2017	0.0021
01.1.608	Cherry	0.391	0.257	0.7540	-0.134	-0.9398	-1.3598	-0.4200	-0.2824	0.3190	0.0033
01.1.609	Grapes	0.188	0.178	1.1904	-0.010	-1.6727	-1.7283	-0.0555	0.1743	0.1826	0.0019
01.1.610	Limes	0.122	0.480	0.6362	0.358	-2.1056	-0.7337	1.3719	-0.4522	0.2612	0.0027
01.1.611	Papaya	0.393	0.176	0.6660	-0.217	-0.9334	-1.7359	-0.8026	-0.4064	0.2704	0.0028
01.1.612	Mango*	0.104	0.445	0.6660	0.341	-2.2632	-0.8101	1.4532	-0.4064	0.2345	0.0024
01.1.701	Black-eyed peas	1.111	1.236	1.0209	0.125	0.1054	0.2122	0.1067	0.0207	1.1727	0.0122
01.1.702	Split peas	1.208	0.575	0.8670	-0.632	0.1886	-0.5530	-0.7416	-0.1427	0.8527	0.0089
01.1.703	Turnip greens	0.736	0.855	1.7099	0.119	-0.3069	-0.1566	0.1503	0.5365	0.7939	0.0083
01.1.704	Red beans	0.479	0.593	1.1058	0.113	-0.7350	-0.5228	0.2123	0.1006	0.5342	0.0056
01.1.705	Garlic	0.934	0.853	0.7948	-0.081	-0.0687	-0.1590	-0.0903	-0.2297	0.8927	0.0093
01.1.706	Onion	0.726	0.664	1.4474	-0.061	-0.3208	-0.4092	-0.0884	0.3697	0.6944	0.0072
01.1.707	Egg plant	0.944	0.888	2.3344	-0.055	-0.0579	-0.1184	-0.0605	0.8478	0.9158	0.0096
01.1.708	Spinach	1.172	1.058	0.7878	-0.114	0.1588	0.0562	-0.1026	-0.2385	1.1139	0.0116
01.1.709	Shallot	0.525	0.506	1.1231	-0.020	-0.6441	-0.6821	-0.0381	0.1161	0.5153	0.0054

COICOP Code	Item Name	Expenditure Share 2010	Expenditure Share 2015	Avg. CPI 2015/100	ΔShare	ln Share 2010	ln Share 2015	Δln of Share	ln PriceRel	Initial Weights	Weights
		Original Data		Step iii		Step i	Step i	Step ii	Step iv	Step v&vi	Step vii
01.1.710	Ochre	0.746	0.694	1.3458	-0.052	-0.2932	-0.3652	-0.0720	0.2970	0.7197	0.0075
01.1.711	Pumpkin	0.525	0.809	1.2033	0.283	-0.6441	-0.2126	0.4315	0.1851	0.6567	0.0069
01.1.712	Tomatoes	0.545	0.771	2.2518	0.226	-0.6061	-0.2599	0.3463	0.8117	0.6518	0.0068
01.1.713	Squash	0.246	0.339	1.8135	0.093	-1.4021	-1.0819	0.3202	0.5953	0.2900	0.0030
01.1.714	Plantains	0.863	1.337	1.4753	0.474	-0.1478	0.2901	0.4379	0.3889	1.0823	0.0113
01.1.715	Long beans	1.360	1.143	1.1958	-0.217	0.3074	0.1336	-0.1737	0.1788	1.2483	0.0130
01.1.716	Cabbage	0.578	0.828	1.1446	0.249	-0.5474	-0.1889	0.3585	0.1350	0.6957	0.0073
01.1.717	Carrots	0.261	0.838	0.8745	0.577	-1.3421	-0.1763	1.1658	-0.1341	0.4950	0.0052
01.1.718	Cucumber	0.193	0.324	1.1595	0.131	-1.6460	-1.1275	0.5186	0.1480	0.2527	0.0026
01.1.719	Cassava	0.373	0.474	1.4207	0.101	-0.9863	-0.7465	0.2399	0.3512	0.4215	0.0044
01.1.720	Eddoes	0.627	0.678	1.2815	0.051	-0.4674	-0.3884	0.0790	0.2480	0.6520	0.0068
01.1.721	White potatoes	1.816	1.541	2.1072	-0.276	0.5969	0.4322	-0.1647	0.7454	1.6748	0.0175
01.1.801	Sugar (dark)	4.627	2.569	1.0136	-2.058	1.5320	0.9436	-0.5884	0.0135	3.4980	0.0365
01.1.802	Sweets	0.198	0.163	1.1201	-0.035	-1.6201	-1.8140	-0.1940	0.1134	0.1799	0.0019
01.1.803	Chocolates	0.287	0.333	1.0049	0.047	-1.2494	-1.0982	0.1512	0.0049	0.3095	0.0032
01.1.804	Ice cream	0.277	0.774	1.2643	0.498	-1.2854	-0.2559	1.0295	0.2346	0.4834	0.0050
01.1.901	Baby food (mainly milk)	0.152	0.634	1.1502	0.482	-1.8824	-0.4559	1.4266	0.1400	0.3376	0.0035
01.1.904	Salt	0.434	0.230	1.0152	-0.204	-0.8351	-1.4716	-0.6365	0.0151	0.3209	0.0033
01.1.903	Curry powder	0.591	0.584	1.1492	-0.007	-0.5257	-0.5383	-0.0126	0.1391	0.5874	0.0061
01.1.910	Black pepper	0.228	0.307	1.1059	0.079	-1.4770	-1.1799	0.2971	0.1007	0.2659	0.0028
01.1.911	Masala	0.170	0.258	0.6062	0.088	-1.7721	-1.3558	0.4163	-0.5006	0.2108	0.0022
01.1.902	Tomato paste	0.956	0.673	1.2719	-0.283	-0.0445	-0.3955	-0.3509	0.2405	0.8066	0.0084
01.1.908	Vinegar	0.241	0.443	1.2120	0.202	-1.4229	-0.8139	0.6090	0.1923	0.3319	0.0035
01.1.906	Celery	0.287	0.497	1.0222	0.210	-1.2494	-0.6996	0.5498	0.0220	0.3822	0.0040
01.1.905	Red pepper	0.348	0.192	3.2345	-0.155	-1.0568	-1.6492	-0.5924	1.1739	0.2623	0.0027
01.1.909	Baking powder (prepd.)	0.238	0.189	1.2120	-0.049	-1.4335	-1.6635	-0.2300	0.1923	0.2130	0.0022
01.1.907	Ketchup	0.256	0.636	1.0150	0.379	-1.3617	-0.4531	0.9086	0.0149	0.4176	0.0044
01.2.102	Coffee - extract	0.741	0.507	1.2334	-0.234	-0.3000	-0.6795	-0.3795	0.2098	0.6164	0.0064
01.2.103	Tea	0.502	0.740	1.0408	0.238	-0.6885	-0.3010	0.3875	0.0400	0.6135	0.0064
01.2.104	Milo	1.243	1.102	1.2716	-0.141	0.2176	0.0969	-0.1207	0.2403	1.1710	0.0122
01.2.105	Ovaltine	0.249	0.372	1.0826	0.124	-1.3918	-0.9880	0.4038	0.0793	0.3063	0.0032
01.2.202	Malt	0.454	0.366	1.6667	-0.088	-0.7894	-1.0053	-0.2159	0.5108	0.4084	0.0043
01.2.203	Soft drink	1.246	3.428	1.0826	2.183	0.2197	1.2321	1.0124	0.0793	2.1559	0.0225
	Totals									95.8610	1.0000

Procedures for calculating a weighted regression (Step viii**)**

Calculate a weighted average for each variable:

avg_Δln of Share = -0.013670396
Formula: SUMPRODUCT(<Δln of Share-data>,<Weights>)/SUM(<Weights>)

avg_ln PriceRel = 0.078093397
Formula: SUMPRODUCT(<ln PriceRel-data>,<Weights>)/SUM(<Weights>)

The slope of the weighted linear regression is:

Formula: SUMPRODUCT(<Δln of Share-data>–<avg_Δln of Share->,<ln PriceRel-data>–<avg_ln PriceRel>,<Weights>)/
SUMPRODUCT((<ln PriceRel-data>–<avg_ln PriceRel>)^2,<Weights>)

Slope of Wgt Regr = 0.012887372
–(η-1) = 0.012887372
η= 0.987112628

The intercept of weighted linear regression is:

Intercept =-0.014676815
Formula: <avg_Δln of Share> - <avg_ln PriceRel>*<slope_of_wgt_regr>