Chapter 7 Maintaining the Sample

A. Introduction

7.1 Chapter 4 focuses on the drawing of a static sample of price quotes for the price reference period for use in the compilation of the Consumer Price Index (CPI). The sample design aimed at obtaining a sample of prices that, along with the weighting system (as described in chapter 3), was representative of household expenditure. This representativity followed a multi-stage sample design including the selection of geographical areas, products, outlets, and representative varieties within outlets, as further developed in chapter 4. Once varieties were selected for pricing, the primary need was for the same varieties to be priced in subsequent months. In the introduction to chapter 6, the use of the matched model method (MMM) was recognized as the accepted approach to ensure that the measurement of price changes was untainted by changes in the quality of the variety whose prices are compared. Yet the sample selected in the price reference period, while representative at that point in time, will gradually and increasingly become out of date. The MMM while devised for, and useful to, the measurement of a constant quality basket of items, can fail in three important respects: missing varieties, issues of sampling maintenance, and new goods and services (hereafter “products”). There is a need to maintain the representativity of the sample.

7.2 Missing varieties for the MMM were the subject of chapter 6, which outlines the treatment of temporarily and permanently missing variety prices, the latter requiring a replacement variety. For cases in which the replacement was of a different quality to the permanently missing variety—it was non-comparable—several implicit and explicit methods of quality adjustment to prices, and the choice between them, were discussed. Yet replacing permanently missing variety prices is unlikely to be sufficient to maintain the representativity of the variety sample. In many product areas, new brands and varieties will emerge each month with increasing expenditures directed to them and expenditures on existing “representative” varieties diminish. Comparable and non-comparable replacements are undertaken only when variety prices are permanently missing. The nature, extent, and timing of these one-for-one replacements are designed not with a primary need of replicating the dynamic sample of price changes but their suitability for measuring constant-quality price change. In this chapter, attention is turned to the two other reasons why the MMM may fail: sampling maintenance and new goods. The MMM by its nature cannot include new goods. However, even if new goods were effectively included, and one-for-one constant-quality replacements were enacted for permanently missing variety prices, there would still be issues of sampling maintenance. While it is recognized that variety replacement and new goods both encompass sampling maintenance, the restrictive nature of the MMM—a method designed for constant-quality price measurement—confines the sampling to its initial static selection during the price reference period resulting in inadequacies in its ability to represent the dynamic population of price changes. CPI compilers in adopting the MMM are faced with missing prices and have a need to impute temporarily missing prices and bring in replacement varieties following the principles and methods of chapter 6. Yet there is also a need to further recognize the remaining issues of sampling maintenance and treatment of new products in this chapter. The three sources of potential error from the MMM are briefly outlined below.
7.3 **Missing varieties.** A problem arises when the variety to be priced is missing in the outlet or no longer sold. If temporarily missing, an imputation may be made of the price the variety would have had, had it been available. If permanently missing, the price collector may choose a replacement variety of a comparable quality, and its price would be directly compared with the missing variety’s price. If the replacement is of a non-comparable quality, the overlap method might be used to “link in” the price change of the replacement, or an explicit price adjustment undertaken. This was the subject of chapter 6, sections C through F. In section G of chapter 6 a caveat was added. For varieties in product groups where model replacements are frequent, continued long-run matching would deplete the sample, and quality adjustment becomes unfeasible on the scale required.

7.4 **Issues of sampling maintenance.** Product groups are selected when updating a CPI based on their relative expenditures and representative varieties selected and priced in outlets, as discussed in chapter 9. General specifications may be given for the variety to be selected and priced in each outlet, such as the size and type, and the selection of the specific representative variety, including brand and features, undertaken at a visit to the outlet—the initiation of the pricing—at which the most popular variety is selected, its detailed specifications recorded, and priced in this and subsequent months. The variety is representative as at the month of initiation. The matching of prices of identical varieties over time, by its nature, is likely to lead to the monitoring of a sample of varieties increasingly unrepresentative of the population of transactions. Many new varieties of the product may be sold, but the sample will be constrained to the original matched varieties, and new varieties only introduced on a one-for-one variety replacement basis. Price collectors may keep with their selected varieties until they are no longer consumed—that is, continue to monitor varieties with unusual price changes and limited sales. Yet on variety replacement, price collectors may select unpopular comparable varieties to avoid explicit quality adjustments; obsolete varieties with unusual price changes are replaced by near-obsolete varieties that also have unusual price changes, compounding the problem of unrepresentative samples. The substitution of a variety with relatively high sales for an obsolete one has its own problems, since the difference in quality is likely to be substantial and substantive, beyond what can be attributed to, say, the price difference in some overlap period. One would be in the last stage of its life cycle and the other in its first. The issue has implications for sample rotation and variety substitution. An extreme case of a change in the population of items/varieties to be included in the CPI is when a previously free, say subsidized, item is newly charged.

7.5 **New goods.** A third potential difficulty arises when something “new” is sold. The problem of new “goods” extends to new services, new varieties of an existing product, and new products. If an variety price is missing in a period, there will be replacement varieties. In this chapter, evolutionary are distinguished from revolutionary goods. The former are new product varieties which are essentially a replacement of a previously popular product. They are extensions of an existing product whose features and, in consequence, “quality” have changed. Revolutionary goods are goods that are substantially different from pre-existing goods. They cannot be easily linked to the service flow or production technology of existing goods and services. They represent a distinct departure from previously available products to the extent that it is a step change in terms of technology or utility/benefit to the customer.
When a new good is produced and consumed, there is a need for it to be included in the index as soon as possible, especially if the good is expected to be responsible for relatively high sales. New goods might have quite different price changes than existing ones, especially at the start of their life cycle. In the initial period of introduction of a new good, producers and retailers often set higher prices than might be attainable once the market settles into a competitive equilibrium. But by definition, there is no price in the period preceding the introduction of the new good. So even if prices of new goods were obtained and included in the index as from the initial introduction date, there would still be something missing—the initial high price producers can reap by exploiting any monopoly power compared with its hypothetical price in the period prior to its introduction. There is a related problem of “old” goods. Again, the price changes of such goods may be unusual. The goods will be at the end of their life cycle and may be priced at unusually low prices to clear the way for new models.

The problem of missing varieties was the subject of chapter 6. In this chapter, issues of sampling maintenance arising out of the matched models approach and the problem of introducing new goods into the index are considered. As with missing varieties, the sampling issues and new goods problem can be quite severe for CPIs. New good and varieties of existing goods can arise from newly introduced lines in existing domestic outlets, new domestic outlets (with a possible different service level), imports, and new forms of trade such as e-commerce.

B. Issues of sampling maintenance and matching

1. Introduction

The matching procedure has at its roots a challenge. Matching is designed to avoid price changes being contaminated by quality changes. Yet its adoption constrains the sampling to a static universe of goods that exists in the price reference period. Outside of this there is of course something more: goods that exist in the reference period but not in the current period, and are therefore not matched; and similarly, those new goods existing in the current period but not in the reference one—the dynamic universe. The challenge is that the goods not in the matched universe, the new goods appearing after the reference period and the old goods that disappeared from the current period, may be the ones whose price changes differ substantially from existing matched ones. They may embody different technologies and be subject to different (quality-adjusted) strategic price changes. The same device used to maintain a constant-quality sample may itself give rise to a sample biased away from technological developments. Furthermore, when this sample is used to make imputations (chapter 6 Sections D.1 and D.2) as to the price changes of replacement goods, it reflects the technology of a sample not representative of current technological changes. The MMM similarly constrains the incorporation of new goods.

The above problem has been outlined in terms of a variety having to “exist” in both of the periods being compared. The concern in this respect for price collection within an outlet is for the price collector being able to return a price quote for the month in question for the comparable, matched variety selected and priced in the previous period. Of course, a variety may not be found by the price collector on an outlet shelf in a given month and thus not “exist” in the above sense, but still be domestically consumed, sold by outlets not
sampled or sold by the outlet on a day of the month not sampled. Similarly, a price may be posted but there may be no or limited expenditure against it.

7.10 Consider three universes:
- An intersection universe, which includes only matched goods;
- A dynamic double universe, which includes all goods in the base comparison period and all in the current period, although they may be of different qualities; and
- A replacement universe, which starts with the base period universe but also includes one-to-one replacements when a good from the sample in the base period is missing in the current period.

7.11 A sample of representative varieties that comprises only varieties selected for pricing in the base comparison period and having a matched sample provides an estimator of the price change for the intersection universe.

7.12 It is, of course, difficult to ascertain the extent to which matching from the intersection universe constrains the penetration of the sample into the dynamic double universe, since national statistical offices (NSOs) generally do not collect data for the latter. Its extent will, in any event, vary between goods. Scanner data have been used to determine the coverage of intersection and representative variety universes finding, at least for consumer durables, them to be highly restricted.

7.13 A first implication of this is that variety replacement, for permanently missing varieties, is an opportunity to bring in a variety with a relatively large sales value, to increase the coverage of the index. However, the selection of variety substitutes (replacements) by price collectors puts coverage of the sample to some extent under the control of the price collectors. Guidelines and training on directed replacements in particular product groups are merited, as discussed in chapter 5. Where rebasing is infrequent, sample rotation has merit. Sample rotation, as outlined below, is equivalent to initiating a new sample, but for specific product groups that maintain the same weights until the next rebasing. It is particularly useful as a device to refresh the sample for product groups with a high level of sample churn, though as a general rule, a more frequent rebasing is advocated.

2. Item replacement or substitution

7.14 The price collectors often are best placed to select replacement varieties for repricing. They are aware of not only the technological basis of the products being produced and purchased, but also their terms of sale. The selection of the replacement for repricing might be quite obvious to the price collector. There may be only a slight, nominal improvement to the product. For example, the “improved” product can be simply a replacement variety sold instead of the previous one. The replacement could have a different code or model number and will be known to the price collector as simply a different color or packaging. The specification list given to the price collector is a critical prompt as to when a repriced product is different, and it is important that this include all price-determining factors.

7.15 The price collector, supported by CPI staff and prompted by the specification list, takes on the role of identifying whether a variety is of comparable quality or otherwise. If it
is judged to be comparable when it is not, the quality difference is taken to be a price
difference, and a bias will result if the unrecognized quality changes are in a consistent
direction. Informed comparable substitution requires general guidelines on what makes a
good substitute as well as product-specific information on likely price-determining
characteristics. It also requires timely substitution to maximize the probability of an
appropriate substitute being available. Chapters 5 and 6 provide further information on the
need for and type of training to be provided to price collectors in this regard. The selection
of replacement varieties is very much product-specific and guidelines for price collectors
should focus on specific product groups and tailored to their needs.

7.16 The results from hedonic regressions can be useful in the selection of varieties and
their replacements. The results provide an indication of the major quality factors that make
up the good or service, in terms of explaining price variation. Not only would the selection
of varieties be more representative, but the coefficients from hedonic regressions, for their
subsequent use to estimate quality-adjusted prices, would be more tailored to the sample in
hand.

7.17 On repricing, price collectors traditionally are required to find substitute varieties
that are as similar as possible to the varieties being replaced. This maximizes the likelihood
that the old and replacement variety will be judged equivalent and so minimizes the need to
employ some method of quality adjustment. Yet, replacement varieties should be chosen so
that they make the sampled varieties more representative of the dynamic universe. The
inclusion of a popular replacement variety to refresh the sample—one at the same point in
its life cycle as the original popular one selected in the base period—allows for a useful and
accurate price comparison and increases the chance of an appropriate quality adjustment
being undertaken. It is of little merit to substitute a new variety with limited sales for a
missing variety with limited sales, just because they have similar features of both being
“old.” The index would become more unrepresentative. Yet if replacements are made for
varieties at the end of their life with popular replacements varieties at the start of their life,
the quality adjustment will be substantial and substantive. More frequent sample rotation or
directed replacements will be warranted for some item areas. The selection of replacement
varieties:

- Offers an opportunity to cut back on and possibly remove sample bias in the period
  of replacement, though not prior to it;
- The more frequent the replacement, the less the bias;
- If there is more than one new (replacement) variety in the market, there may still be
  bias since only the most popular one will be selected, and it may be at a different
  stage in its life cycle than others and priced differently;
- The analysis assumes that perfect quality adjustments are undertaken on
  replacements. The less frequent the replacement, the more difficult this might be,
  because the very latest replacement variety on the market may have more substantial
differences in quality than earlier ones;
- If the replacement variety has relatively high sales, is of comparable quality, and at
  the same stage in its life cycle as the existing one, then its selection will minimize
  bias but would also be at the end of its life cycle and subject to replacement soon;
• If there is more than one new (replacement) variety and the most comparable one is selected at the old technology, it will have low market share and unusual price changes;

• Given advance market or consumption information, replacements undertaken before obsolescence are likely to increase the sample’s share of the market, include varieties more representative of the market, and facilitate quality adjustment.

3. Outlet replacement

7.18 The problem of variety substitution is analogous to the problem that arises when an outlet closes. It may be possible to find a comparable outlet not already in the sample. A comparable one may be another outlet, possibly a franchise, in the same chain. It may be that there is a non-comparable outlet for which, in principle, an adjustment can be made for the better quality of service of the new one. It is not unusual for a new outlet to close following the introduction of a new one. Thus, there is an obvious replacement outlet. However, if the new outlet has comparable prices but a better range of varieties, delivery, and service quality, there is a gain to purchasers from substituting one outlet’s output for the other. Yet, since such facilities have no direct price, it is difficult to provide estimates of the value of such services in order for an adjustment to be made for the better quality of service of the new one. Simply rotating the new outlet into the sample via the overlap method would, as outlined in chapter 6, miss the quality difference. The index thus would have an upward bias, which would be lost on rebasing. In such cases, substituting an old outlet for a new one that provides a similar standard of service would be preferable.

4. Sample rotation, chaining, and hedonic indices

7.19 In the previous section, the replacement universe was considered with replacements taking place as substitutes for missing or “obsolete” varieties. The double-universe is preferable since it includes information on all varieties in each period. This double universe is not only concerned with replacement (representative) varieties, but new varieties within the product group, and new product groups.

7.20 For some product groups, the samples of products used will become quite out of date if it was left to the next rebasing for the sample to be reinitiated. This is especially so if the rebasing is infrequent. Sample rotation is equivalent to initiating a new sample, but it is for a product group which maintains the same weights until the next rebasing. Sample rotation is undertaken for specific product groups at different points in time to save on the resources required if all the product groups were to have their products rotated at the same time. The criteria for choice of product groups to benefit from sample rotation, and the timing of the rotation, should be clearly and openly scheduled in advance according to objective criteria.

7.21 It is important also to recognize the interrelationships among the methods for handling product rotation, product replacement, and quality adjustment. When CPI product samples are rotated, this is a form of product substitution, except that it is not “forced” by a missing variety price but is undertaken for a general group of items/varieties to update the sample. Rotation has the effect of making future forced replacements less likely. Yet the assumptions implicit in its use are equivalent to those for the overlap adjustment technique:
price differences are an adequate proxy for the difference in price per unit of quality between products disappearing from the sample and replacement products. Consider the initiation of a new sample of items. Prices for the old and new sample are returned in the same month and the new index is compiled on the basis of the new sample, with the results being linked to the old. This is an implicit use of the overlap method, in which all price differences between the new and old products are taken to be estimates of the price differential due to quality differences. Assume the initiation is in January. The prices of an old variety in December and January are 10 and 11, respectively, a 10 percent increase, and those for the replacement variety in January and February are 16 and 18, respectively, an increase of 12.5 percent. The new variety in January is of a better quality than the old, and this difference in quality may be worth $16 - 11 = 5$; that is, the price difference is assumed to be equal to the value of the quality difference, which is the assumption implicit in the overlap method. Had the price of the old product in December been compared with the quality-adjusted price of the new product in January under this assumption, the price change would be the same: 10 percent (that is, $(16 - 5)/10 = 1.10$). If, however, the price difference in January was an inappropriate reflection of the quality difference, say the old variety was being dumped at an unrealistically low price to clear the market for the new one, then the implicit assumption underlying the overlap method does not hold. In practice, the need to simultaneously replace and update a large number of products requires the assumptions of the overlap method. This process should not be regarded as error-free, and in cases where the assumptions are likely to be particularly untenable (discussed in chapter 6, Section D.2), explicit adjustments of the form discussed in chapter 6, Section E should, resources permitting, be used.

Sample rotations to freshen the sample between rebasing are expensive exercises. However, if rebasing is infrequent and there is a substantial loss of products in particular product groups, then this might be appropriate for those product groups. In the next section the need for a metadata system to facilitate such decisions will be outlined. The use of more frequent sample rotation aids the process of quality adjustment in two ways. First, the updated sample will include newer varieties, comparable replacements with substantial sales will be more likely to be available, and non-comparable ones will be of a more similar quality, which will aid good explicit quality adjustments. Second, because the sample has been rotated, there will be fewer missing products than otherwise and thus less need for quality adjustments.

A natural extension of more frequent sample rotation is to use a chained formulation in which the sample is reselected each period. The prices of all varieties available in each successive linked comparison are compared: those available, for example, in both January and February are compared for the January to February link, while those available in both February and March are compared for the February to March link. The index for January to March is derived by successive multiplication of the two binary links. In chapter 6, Section G.3, the principles and methods of this chained formulation were outlined in the context of sectors in which there is a rapid turnover of models, and such principles are echoed here. Similarly, the use of hedonic indices as outlined in chapter 6, Section G.2 and short-run comparisons discussed in chapter 6, Section H might be useful in this context.
7.24 The above chained formulation allows the price changes of a new model to be included in the index as soon as the model can be priced for two successive periods. For example, a new model that appears in period 3 can be introduced into the index in the period 3 to period 4 link. However, the new model’s effect on the price index in the initial period of introduction, period 3 for the period 2 to period 3 link, is ignored. Similar concerns arise for disappearing models. If the last period a price is observed for a model is period 1, its effect on the price index is lost for the period 1 to period 2 link. The issue and its resolution was outlined in the section in chapter 6 on high-technology product groups; product groups with a high turnover of differentiated models with identifiable price-determining characteristics. Only sub-samples of matched items exist between successive periods and these form biased price comparisons since it is on the dumping of old models that unusually low prices and introduction of new ones that unusually high prices exist. Hedonic price indices allow the price of old model in period 1 to be used in the period 1 to 2 price comparison and the price of the new model in period 3 to be used in the period 2 to 3 price comparison, because it uses the prices of all models in each period, though adjusted for their differences in quality characteristics. There is no need for the MMM.

7.25 Hedonic indices are applicable if a new model/good is not entirely new—it is an evolutionary good in the sense that it is providing more services than those of the old model. The price can be determined in terms of a different combination of the existing character set.

C. The incorporation of new goods

1. What are new goods and how do they differ from quality changes?

7.26 A new model of a product may provide more of a currently available set of service flows. Chapter 6 describes how new models often with quality improvements replaced existing ones. A number of methods were outlined to incorporate the replacement models into the CPI thus helping to maintain the CPI’s representativity. Yet there may be many characteristics of the new model that go beyond the service flow of the existing model.

7.27 The first practical concern with the definition of a new good’s quality changes against an updated existing model is that the former cannot be easily linked to an existing product as a continuation of an existing resource base and service flow because of the very nature of its “newness.” For example, some forms of frozen foods, self-driving and all-electric and hybrid cars, computers, printers, and mobile phones, while extensions of existing products, have dimensions of service that are quite new. Second, new goods can generate a welfare gain to purchasers and surplus to producers when purchased/sold at the very time of introduction and the simple introduction of the new good into the index, once two successive price quotes are available, misses this gain.

7.28 Many product markets are defined by a multitude of brands and differentiated offerings along with a rapid turnover in varieties. In some cases, there are core brands and varieties that may be used for CPI price measurement as representative variety. However, the concern remains that the very rationale for the introduction of new or differentiated brands and varieties is to be distinct and not exact substitutes for existing ones. If the CPI misses both an increasing variety of offerings and their distinctive quality improvements, the index may misrepresent actual price inflation. However, the magnitude and turnover in
offerings in differentiated markets can make the definition and measurement of quality change and ‘newness’ impractical.

7.29 On way in which a new good can be defined is in terms of the absence of substitutes and the ensuing monopolistic power. For example, some new movies, digital games, and toys may have quite small cross-elasticities with other movies, games and toys; their shared service is to provide entertainment and they are only similar in this respect. The same argument may apply to new books and breakfast cereals. There are many new forms of existing products which are not easily substitutable for similar products but can generate consumer utility well above that of the pre-existing counterparts, and not always sold at a higher price.

7.30 A more practical classification that will meet the needs of CPI compilation is to consders evolutionary and revolutionary goods. Evolutionary goods are new product varieties which are essentially a replacement of a previously popular product. They are extensions of an existing product whose features and, in consequence, “quality” have changed. Examples of evolutionary products would be new models of household appliances such as refrigerators and washing machines where improvements in quality are introduced from time to time. Consequently, in theory at least, it should be possible to quality adjust for any differences between a pre-existing good and an evolutionary good, as outlined in chapter 6. Where the new model is a one-for-one replacement with the old model, the sample is maintained. However, where there are a large number of new brands/varieties spawned by a new innovation, the one-on-one replacement will not reflect the representativity of the sample. Revolutionary goods are goods that are substantially different from pre-existing goods. An entirely new product represents a good or service that:

- Was not included and could not be included in the price index during the initial selection of the current market basket and which is now available for possible inclusion in the index.
- Cannot be easily linked to the service flow or production technology of existing goods and services. That is, it represents a distinct departure from previously available products to the extent that it is a step change in terms of technology or utility to the customer.
- Has a recognizable and generally accepted new benefit to consumers as a result of becoming available.

7.31 The last two points help to distinguish a revolutionary product from an evolutionary product. A revolutionary product is an entirely new good or service that is not closely tied to a previously available product. A revolutionary product tends to be a good or service that is expected to satisfy some need in a new way and is unlikely to fit neatly into an existing CPI item category. For example, a mobile phone, whilst in one way an extension of an existing flow of service (telecommunication), has a dimension of service which is new (it provides the opportunity to make “mobile” calls away from a fixed telephone) and is a distinct product from existing landline telephone services (it is a step change in technology). It is therefore an example of a revolutionary product.

7.32 Quality adjustments to prices are therefore suitable for evolutionary goods, but unsuitable for revolutionary goods. The definitions are designed to distinguish between the
two types of goods not in terms of what is analytically appropriate, but by what is practically meaningful for the needs of CPI compilation and calculation. Practical needs are important in this context, especially because the methods for providing reliable estimates of consumer surplus on a large-scale basis are not practically possible given the substantial resource needs of data and econometric expertise.

2. **Major concerns with the incorporation of new goods**

7.33 There are two major concerns regarding the incorporation of new goods into a CPI. First, is their identification and detection; second is the related decision on the need and timing for their inclusion. This refers to both the weight and price changes of the new goods.

7.34 For example, the levels of expenditure on mobile phones was in some countries at such a significant level that their early inclusion in CPIs became a matter of priority. They simply rose from nothing to be a quite large proportion of expenditure in their product group. Furthermore, their price changes were atypical of other goods in their product group. Many new goods can command substantial sales and be the subject of distinct pricing strategies at introduction prompted by a need to recuperate research and development expenditure and take advantage of an opportunity to expand market share and/or make super-normal profits, as for example with high-technology goods, such as computers, pharmaceuticals, and entertainment gaming devices.

7.35 Waiting for a new good to be established or waiting for the rebasing of an index before incorporating new goods may lead to errors in the measurement of price changes if the unusual price movements are ignored at critical stages in the good’s life cycle. NSOs should have strategies in place for the early identification of new goods and mechanisms for their incorporation either at launch, if preceded by major marketing campaigns, or soon after, if there is evidence of market acceptance. This should form part of the metadata system. Waiting for a new good to achieve market maturity may result in an implicit policy of ignoring the very different price movements that accompany their introduction. This is not to say that new product will always have different price changes. New good prices may be very close to, or even lower than, the original ones and serve to expand the new good’s market share. There may be something in the “newness” of the technology and production that enables a price reduction for a better product.

3. **Methods for incorporating new goods**

7.36 The methods outlined here include both those that fall under what should be normal CPI procedures and those that would require exceptional treatment. Example of the methods are given in the *Practical Guide to Producing Consumer Price Indices* (United Nations: Geneva and New York: 2009: sections 8.10–8.33), some of which are reproduced below.\(^1\) In the former case the focus will be on *evolutionary goods*. Consideration will be

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(continued)
given in to the rebasing of the index, rotating of products, introduction of new goods as replacements for discontinued ones. Much use will be made of the overlap method where the price changes of new goods are linked/spliced on to the index. Of importance in this context of maintaining the representativity of the sample is a move, where appropriate, away from one-for-one replacements and the introduction of appropriate weights for the new goods. The overlap method invokes some highly restrictive assumptions, and these will be explored in the context of explicit quality adjustments, all following the principles and practices described in chapter 6. The section on revolutionary goods is more problematic from a practical measurement perspective. The focus here will be on an understanding of how such new goods can be incorporated into the CPI, but on the need for users to be made aware of the conceptual limitations of the resulting measures.

Evolutionary goods

Updating and chaining

7.37 A new good may be readily incorporated in the index at the time of updating or revising the index. If the new good has, or is likely to have, substantial sales, and is not a replacement for a preexisting one, or is likely to demand a much higher or lower market share than the preexisting one it is replacing, then new weights are necessary to reflect this. New weights are fully available when updating. There will be a delay in the new product’s full inclusion, and the extent of the delay will depend on how close its introduction is to the next rebasing, the frequency with which the index is updated, and the time lapse between determining the new expenditure weights from a household budget survey (HBS) (as described in chapter 3), and their use in index compilation (please see chapter 9 for more information). However, even if the index was updated annually and chained, it would take until the annual update before weights could be assigned, and even then, there might be a further delay in the sampling and collating of the survey results for the weights. Annual updating allows for a relatively early introduction of new goods and is advised when the weights are not keeping pace with innovations in the product market.

7.38 Rebasing provides two further opportunities to maintain/replenish the sample. The first is to develop a new set of elementary aggregates. Some elementary aggregates may no longer have a sufficiently substantive weight and expected longevity to merit inclusion in the CPI, according to some say cut-off criterion, as outlined in chapter 4, while others may have now passed the cut-off and be expected to continue to gain in importance. The formal inclusion of new evolutionary and revolutionary goods at this juncture, along with their weights, and removal of “obsolete” elementary aggregates, provides an opportunity for a NSO to formally announce and integrate new goods into the CPI along with their commensurate weights. The price changes of the new CPI basket are chain-linked onto the price changes of the old, as described in chapter 9.

7.39 The second is the re-initialization of the sample of outlets and representative varieties within outlets, as outlined in chapter 4. On re-basing, the sampling of outlets for the existing elementary aggregates can be revisited with the purpose of introducing new outlets, especially those invoking new retailing technologies, including internet shopping, and
remove obsolete outlets. There might also be a need for a re-weighting and/or switching of
the sample towards specific geographical area, for example because of new metropolitan
areas being developed due to new transportation links or job opportunities. Within each
outlet, is the opportunity to re-appraise the representative variety(s) selected for regular
pricing and replace it as necessary.

Sample rotation (re-initiation)

7.40 In many countries rebasing is infrequent. Rather than continuing to utilize a sample
of varieties that have become increasingly unrepresentative, NSOs may select new
outlets/samples of representative varieties between rebasing. This need not be undertaken
for all product groups in the same period, with different major groups of the Classification
of Individual Consumption by Purpose (COICOP) having their samples updated
periodically, and perhaps with different frequencies, according to needs and resources.
During this process the weights remain constant until the next rebasing. This should involve
a re-appraisal of the product groups, geographies, outlets and representative varieties within
outlets, and the elementary aggregates. This may be undertaken on a phased basis to reduce
the workload with more frequent rotations directed to product groups experiencing rapid
changes. However, unlike rebasing, there is neither a comprehensive introduction of new
weights nor a sampling basis for identifying new geography, outlets, and product selection.
Yet a continuing matching of prices of goods that are unrepresentative of expenditure
patterns is also not desirable. Where resources do not permit a regular rebasing sample
rotation provides a viable mechanism for making some in-roads into maintaining sample
representativity, but it is not a complete solution.

Sample rotation (re-initiation) in high-turnover product groups and hedonic regressions

7.41 In COICOP classes where new products are continuously appearing and old ones
disappearing, the sample of products can quickly become outdated and be unrepresentative
of what consumers are purchasing. The existing sample within a class may cover a broad
and representative range of varieties that were available in the market during the base period
but is not representative of all the varieties currently purchased. In such a case, the sample of
varieties within each elementary aggregate can be totally re-sampled to reflect current
spending patterns. One approach to facilitate the sample rotation or re-initiation process
uses an overlap. The old and new sample prices are collected in an overlapping period. The
old sample is used to calculate the “old” price index up to and including the overlap period;
the new sample from the overlap period onwards is used to calculate the “new” price index,
the “old” and “new” indices being linked together as outlined in chapter 6.

7.42 Care should be exercised in the application of this technique for product areas
where there is a rapid change in the model replacement. New generations of electronic
goods such as television sets, for example, might be incorporated into the price index using
the overlap method. The new goods would have their price change measured when two
successive price quotes are available, possibly at the same price at the start of the new
model’s life cycle, and this would be linked to the price change of the old model near the
end of its life-cycle, it is replacing. The method might miss any effective fall in (quality-
adjusted) prices from new technological developments.

7.43 Modern data sources including scanner data and web-based data, as outlined in
chapter 10, enable a continuous resampling of such products with high rates of technological
change. They also include price-determining characteristics data. For example, for washing machines, the prices, spin-speeds, capacity, dimensions, programs, brand, and many more salient price-determining characteristics are provided alongside the price for each model. Hedonic regressions were advocated as one option in chapter 6 as a means of avoiding the pitfalls of over-using the overlap method.

7.44 Yet it is not necessary for NSOs to wait until a product is obsolete before the new one is introduced. It is quite feasible for NSOs to preempt the obsolescence of the old product and direct an early substitution of the new. In some product groups, the arrival of a new good is well advertised in advance of the launch, while in others it is feasible for a NSO to have more general procedures for directed substitutions, as will be outlined below. Without such a strategy and infrequent rotation and rebasing, a country’s CPI would be open to serious new good bias.

Forced replacement

7.45 Chapter 6 describes how replacements of varieties within an elementary aggregate were forced by the existing variety becoming permanently missing. The replacements helped maintain the representativity of the index simply by introducing a newer, more representative, variety into the index. The replacement may have been comparable, requiring no quality adjustment, or non-comparable, requiring an implicit or explicit quality adjustment. The specific application illustrated in Tables 6.3 and 6.4 were for a one-on-one replacement. In practice, with new products, an existing technology may be supplemented by a wider variety of replacements; relatively straightforward land-lines, for example, with a multitude of mobile phone hardware, carriers and packages.

7.46 It is quite straightforward to extend the principles of replacements outlined in chapter 6 to more than one representative variety simply by using a weighted (or unweighted) price change of more than one replacement variety. Indeed, existing samples may be supplemented by new varieties even when a replacement is not motivated by a permanently missing variety. A comparison at the elementary aggregate level between, for example, prices in 2020 and prices in June 2021 may be undertaken in two stages: first, by comparing average prices for several matched representative varieties in 2020 with average prices of comparable representative varieties in May 2021; multiplied by second, a comparison of average prices in May 2021 compared with June 2021. The basket of representative varieties in the May to June 2021 stage may include new representative varieties in addition to the replacements for the ones used in the 2020 to May 2021 stage. In introducing such representative varieties there is an implicit weighting, and care has to be exercised to ensure it is meaningful. At the elementary level of aggregation, the Jevons index is the ratio of geometric means, which is equal to the geometric mean of price relatives (for more information see chapter 5 of the publication Consumer Price Index Theory). Equal (implicit) weight is given by the Jevons index to each variety’s price relative. Explicit weights may also be used.

Sample augmentation

7.47 Sample augmentation does not require a representative item to be missing, as was the motivation in chapter 6. With sample augmentation, new items or varieties are introduced into the index. To illustrate sample augmentation, take the case where a new canned fish, tuna packed in water, has been recently introduced to the retail market and has
significant popularity in the shops. This new variety can be added to the existing sample in the elementary aggregate for canned fish as shown in Table 7.1.

7.48 Period 1 displays the sample currently used. The NSO then decides to add the supplemental variety (tuna in water) in period 2. But prices for two periods are required before there is a matched pair. The period 2 elementary aggregate index (140.6) is computed using the geometric mean of short-term price relatives for the original 5 varieties (1.0307) multiplied by the previous period elementary aggregate index (136.4). In period 3 the new variety’s price is available in both periods and the elementary aggregate index (143.3) is calculated by taking the geometric mean of short-term price relatives for the 6 available varieties (1.0190) multiplied by the period 2 price index (140.6). To estimate the period 2 variety level index for “tuna in water”, we assign it the same value as the elementary aggregate index (140.6). This implicitly assumes that the price trend for the new variety from the base period is the same as that for all the other varieties within the elementary aggregate. If the long-term price relative method is used to calculate the elementary aggregate index, then the base price for tuna in water is estimated by dividing the first price of the new variety (60.00) by the long-term price change (1.406) to get a base price of 42.66. The aggregate index is calculated as the geometric mean of the variety indices.

7.49 The example in Table 7.1 is for augmenting the sample using a single additional variety. As outlined above, the principles can be readily extended to including more than one representative variety, or a weighted average thereof.

Table 7.1 Example of sample augmentation

<table>
<thead>
<tr>
<th>Variety</th>
<th>Period 1</th>
<th>Period 1</th>
<th>Period 2</th>
<th>Period 2</th>
<th>Period 3</th>
<th>Period 3</th>
<th>Period 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Price</td>
<td>Price</td>
<td>Price</td>
<td>Price</td>
<td>Price</td>
<td>Price</td>
<td>Price</td>
</tr>
<tr>
<td>Canned mackerel</td>
<td>125.0</td>
<td>50.00</td>
<td>51.00</td>
<td>1.0200</td>
<td>127.5</td>
<td>51.00</td>
<td>1.0000</td>
</tr>
<tr>
<td>(in oil)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canned anchovies</td>
<td>133.3</td>
<td>45.00</td>
<td>47.00</td>
<td>1.0444</td>
<td>139.3</td>
<td>48.00</td>
<td>1.0213</td>
</tr>
<tr>
<td>(in oil)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canned tuna</td>
<td>150.0</td>
<td>50.00</td>
<td>52.00</td>
<td>1.0400</td>
<td>156.0</td>
<td>52.00</td>
<td>1.0000</td>
</tr>
<tr>
<td>(in oil)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canned salmon</td>
<td>145.5</td>
<td>55.00</td>
<td>55.00</td>
<td>1.0000</td>
<td>145.5</td>
<td>57.00</td>
<td>1.0364</td>
</tr>
<tr>
<td>(in oil)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canned herring</td>
<td>130.0</td>
<td>40.00</td>
<td>42.00</td>
<td>1.0500</td>
<td>136.5</td>
<td>43.00</td>
<td>1.0238</td>
</tr>
<tr>
<td>(in oil)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canned tuna</td>
<td>--</td>
<td>--</td>
<td>60.00</td>
<td>140.6</td>
<td>62.00</td>
<td>1.0333</td>
<td>145.3</td>
</tr>
<tr>
<td>(in water)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Revolutionary goods

7.50 Revolutionary new goods, including services, are often high-profile and a failure to properly integrate them into a CPI in a timely manner can damage the credibility of the index.

7.51 For evolutionary goods the sample of products was outdated, and new varieties were selected within existing elementary aggregates. It will occasionally happen that new
revolutionary products arise that are not covered within the scope of existing elementary aggregates but do fall within the more widely-defined COICOP classes. They may be primarily sold by a new outlet, or type of outlet and there will be no previous products to match them against and make a quality adjustment to prices since, by definition, they are substantially different from pre-existing goods. Further, there is no reference-period weight to attach to the new outlet and/or product.

7.52 Adding a new elementary aggregate and re-distributing the weight for the COICOP class to all the elementary aggregates (or varieties) is a way of including such products. Table 7.2 illustrates how to re-distribute the weight.

7.53 Assume that currently telephones have a weight of 60% and fax machines 40%, respectively, within class 08.1.1 (fixed telephone equipment) and that the latest information from importers of telephonic equipment indicates telephones to households (i.e., where sales to businesses have been identified and excluded) now have a market share of 20%, fax machines 10%, and mobile phones 70%. The NSO can use this information to introduce a new elementary aggregate for mobile phones. The weights at the class levels, including class 08.1.0, remain fixed for aggregating to group and division level indices while the relative weighting of the elementary aggregates within the class level are allowed to change as new aggregates are added. Thus, there is a two-tier aggregation system in which the weights at the class level remain fixed at the base period level and the weights within the classes at the elementary aggregate level are changed when new elementary varieties are added, though are constrained to add to the unchanged class weight.

7.54 An overlap approach similar to sample rotation is used here where a new sample is selected, and an elementary aggregate is added. Prices are collected for both the old and new sample in the same period and the old sample is used for compiling the current period index (period 2) and the new sample for the next period (period 3). This is illustrated in Table 7.2.

7.55 For each of the two elementary aggregates in period 1 a new variety to price in period 2 is selected together with a sample of mobile phones for the new revolutionary item. In period 2 the old sample is used to calculate the elementary aggregate indices and to compile the class level index. Thus, the indices for telephones and fax machines are aggregated using the old weights for the elementary indices to derive the period 2 class index ([101.5 x 0.6] + [94.3 x 0.4] = 98.6).

7.56 In period 3 the elementary and class level indices are compiled using the new sample of products and varieties along with the new set of weights for each component. The telephone index in period 3 (99.6) is calculated by using the geometric mean price relative for the three new varieties (0.9811) multiplied by the period 2 price index for telephones (101.5). The same calculation is used to derive the, period 3, elementary index for fax machines (0.9967 x 94.3 = 94.0).

7.57 The new elementary index for mobile phones has no period 2 index to use so the period 2 class level index (98.6) is used as the mobile phone index, on the assumption that the elementary index for mobile phones would have changed by the same percentage, on average, as the other products within the class. Note that this value is also used as the starting index for each of the variety indices within mobile phones. The period 3 mobile phones elementary index is calculated as 98.0 by using the elementary level price relative (0.9933) multiplied by 98.6.
The aggregate index is calculated as the geometric mean of the variety indices. The period 3 class level index is derived using the index for the new elementary aggregates along with the new weights for the elementary indices \([99.6 \times 0.2] + [94.0 \times 0.1] + [98.0 \times 0.7] = 97.9\).

This use of the overlap method is akin to the inclusion of new elementary aggregates on rebasing.

4. Introducing new items and higher-level weights in the CPI in between basket revisions

The example of adding an elementary aggregate presented in Table 7.2 provides a method of introducing a new revolutionary item index, in this case for tablets within the COICOP sub-class 08.1.3.1 (computers, laptops, and tablets) and class 08.3.3 (internet access services). The relevant index now includes the contribution to price change of the tablets item within the sub-class. The sub-class, however, is likely to be under-represented within the corresponding groups (08.1 Information and Communication Equipment and 08.3 Communication services), the division (0.8 Communication) and the all-items CPI, because its weight does not reflect the increased expenditure resulting from the introduction of tablets. In most instances, NSOs are hesitant to change the weights for the sub-class, class, group, and division until a new set of weights for all items can be obtained from a recent HBS. NSOs will typically include the tablet in class 08.1.3.1 and mobile communication services in class 08.3.3 without changing the weights for higher-level aggregates.

Table 7.2 Example of introducing a new elementary aggregate

If the NSO has no plans for conducting a HBS in the near future and is concerned about the possible impact on the statistical integrity of the CPI from not changing the weights for the class, group, and division, there are alternative sources it can consider for updating weights. To update the weights for high-level aggregates, the NSO first needs to estimate weights for each class within the group where the new product is added so that these class indices can be aggregated to the group level. Likewise, new weights are needed for each group to compile the division-level index. In the example for tablets, each group within division 08 contains only one class so weights are needed for just groups 08.1, 08.2, and 08.3. Administrative sources may be able to provide sales revenues from value-added tax data for groups 08.1 and 08.2. Importers of computers, laptops, and tablets may also be able to provide revenue data for group 08.1. Regulatory authorities can be a source for revenue data on internet fees. Alternatively, the national accounts may have expenditure data already compiled for these groups. The next step is to use the revenue information to calculate relative shares for each group and use the share weights to aggregate group indices to the division level. Note that the above procedure will still not be completely satisfactory if it does not incorporate, into Division 08, increases or decreases in the overall share of communications expenditures as a result of the revolutionary new product class.

Table 7.3 contains an example of introducing new weights at the aggregate level when the new items for tablets have been introduced in groups 08.1, 08.2, and 08.3. The
new share weights for these three groups in column 3 sum to 100. The new weights are
introduced into the calculation of the index in period 1. The component price indices for
period 1 (columns 4 and 5) below the total CPI level are the same, but they are aggregated
using different weights. As a result, the index for division 08 (Communication) differs
between column 4 (197.9) and column 5 (192.0). The all-items CPI also differs because of
the different weights — column 4 (386.6) using the old weights and column 5 (393.4) using
the new weights. As the difference between these values is solely due to weighting effects,
the re-weighted index value should not be published - it should only be used to calculate the
current period price change. Footnotes should be provided to explain the introduction of the
new weights.

7.63 To derive the period 2 indices for division 08 and the all-items CPI in column 7,
the indices are compiled using the new weights and the price relatives between period 1 and
period 2 (column 6) are calculated. The price relative for division 08 (0.999229) is applied
to the period 1 published index for 08 Communication (197.9) to derive the period 2
Communication index (197.8). Likewise, the price relative for the total CPI (0.997954) in
column 6 is applied to the period 1 published index for the All-Items CPI (386.6) to derive
the period 2 all-items CPI (385.8).

7.64 These same calculations, using the price change in the re-weighted 08
Communication index and total CPI, are repeated for all future periods (see columns 8 and 9
in Table 7.3).
Table 7.3 Example of introducing new weights for higher-level aggregates

<table>
<thead>
<tr>
<th>COICOP Code</th>
<th>Old Weight</th>
<th>New Weight</th>
<th>Period 1 Index (old wts)</th>
<th>Period 1 Index (new wts)</th>
<th>Price Relative</th>
<th>Period 2 Index (new wts)</th>
<th>Price Relative</th>
<th>Period 3 Index (new wts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total CPI</td>
<td>100.00</td>
<td></td>
<td>386.6</td>
<td></td>
<td></td>
<td>385.8</td>
<td></td>
<td>386.8</td>
</tr>
<tr>
<td>Total CPI using new weights</td>
<td>100.00</td>
<td></td>
<td>393.4</td>
<td>0.997954</td>
<td></td>
<td>392.6</td>
<td>1.002562</td>
<td>393.6</td>
</tr>
<tr>
<td>01 Food and Non-alcoholic Beverages</td>
<td>67.29</td>
<td>58.23</td>
<td>345.2</td>
<td>345.2</td>
<td></td>
<td>342.5</td>
<td></td>
<td>343.7</td>
</tr>
<tr>
<td>02 Alcoholic Beverages and Tobacco</td>
<td>0.54</td>
<td>0.77</td>
<td>453.2</td>
<td>453.2</td>
<td></td>
<td>455.1</td>
<td></td>
<td>454.1</td>
</tr>
<tr>
<td>03 Clothing and Footwear</td>
<td>1.37</td>
<td>1.70</td>
<td>376.9</td>
<td>376.9</td>
<td></td>
<td>375.0</td>
<td></td>
<td>376.0</td>
</tr>
<tr>
<td>04 Housing, Water, Electricity, Gas and Other Fuels</td>
<td>7.91</td>
<td>8.45</td>
<td>572.4</td>
<td>572.4</td>
<td></td>
<td>576.8</td>
<td></td>
<td>577.2</td>
</tr>
<tr>
<td>05 Furnishings, Household Equipment and Routine Household Maintenance</td>
<td>2.54</td>
<td>2.71</td>
<td>401.5</td>
<td>401.5</td>
<td></td>
<td>402.0</td>
<td></td>
<td>402.8</td>
</tr>
<tr>
<td>06 Health</td>
<td>1.47</td>
<td>2.12</td>
<td>215.1</td>
<td>215.1</td>
<td></td>
<td>217.3</td>
<td></td>
<td>217.3</td>
</tr>
<tr>
<td>07 Transport</td>
<td>6.06</td>
<td>8.25</td>
<td>685.9</td>
<td>685.9</td>
<td></td>
<td>687.7</td>
<td></td>
<td>686.5</td>
</tr>
<tr>
<td>08 Communication</td>
<td>2.14</td>
<td>197.9</td>
<td>197.8</td>
<td></td>
<td></td>
<td>197.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication using new weights</td>
<td>4.15</td>
<td></td>
<td>192.0</td>
<td>0.999229</td>
<td></td>
<td>191.8</td>
<td>0.998570</td>
<td>191.5</td>
</tr>
<tr>
<td>08.1 Information and Communication Equipment</td>
<td>0.47</td>
<td>0.24</td>
<td>201.1</td>
<td>201.1</td>
<td></td>
<td>201.1</td>
<td></td>
<td>201.1</td>
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<tr>
<td>08.2 Software</td>
<td>6.54</td>
<td>37.35</td>
<td>179.8</td>
<td>179.8</td>
<td></td>
<td>177.9</td>
<td></td>
<td>177.5</td>
</tr>
<tr>
<td>08.3 Information and Communication Services</td>
<td>92.99</td>
<td>62.41</td>
<td>199.2</td>
<td>199.2</td>
<td></td>
<td>200.1</td>
<td></td>
<td>199.9</td>
</tr>
<tr>
<td>09 Recreation and Culture</td>
<td>1.79</td>
<td>2.55</td>
<td>348.2</td>
<td>348.2</td>
<td></td>
<td>349.6</td>
<td></td>
<td>350.3</td>
</tr>
<tr>
<td>10 Education</td>
<td>1.43</td>
<td>1.98</td>
<td>433.7</td>
<td>433.7</td>
<td></td>
<td>433.7</td>
<td></td>
<td>435.9</td>
</tr>
<tr>
<td>11 Restaurants and Hotels</td>
<td>3.41</td>
<td>5.67</td>
<td>411.2</td>
<td>411.2</td>
<td></td>
<td>413.2</td>
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<td>415.5</td>
</tr>
<tr>
<td>12 Miscellaneous Services</td>
<td>4.05</td>
<td>3.42</td>
<td>391.3</td>
<td>391.3</td>
<td></td>
<td>393.1</td>
<td></td>
<td>397.8</td>
</tr>
</tbody>
</table>
5. Why the use of the overlap method may misrepresent the incorporation of new goods and outlets into a CPI.

Evolutionary goods – similar service flows

7.65 The above methods introduce a new good into the CPI as soon as two successive period’s prices are available. Consider, for example, the digital economy whereby many purchases of existing goods and services can be undertaken in a manner that may enhance search, choice, and convenience of purchase as well as providing the self-same good or service at a cheaper price. While much of this can be disputed for many products, there has been a substantial shift in expenditure towards such digital services.

7.66 Consider a simple stylized example of a taxi service accessed by an application on a mobile phone in which you enter your destination, are matched with driver and vehicle, confirm the pick-up and destination, and are automatically charged. Assume, for this stylized example, the taxi service is cheaper and the overall quality in all other respects equal to that of a traditional taxi, at least on aggregate. The use of the overlap method to replace the existing taxi service with this new replacement would not take account of the effective fall in price experienced by consumers. The overlap method treats the difference in price between the new and old taxi service in the overlap period as an indication of the difference in quality, as described in chapter 6: the new service is treated as being cheaper because it has a poorer service, though this is not the case here. The measured CPI would not include the benefit of the fall in price from the consumer switching to the cheaper taxi service.

7.67 Now assume that the new taxi service was incorporated into the CPI not as a replacement, but within the same elementary aggregate as an additional representative variety—a sample augmentation. It was recognized that this new service was different from the existing one, but it had its own market niche substantial enough to merit inclusion as a new representative variety. Again, the compiler would wait until prices for the new taxi service were available for two successive periods and, using the overlap method, link the new price index into the existing classification for taxi services. And again, the cheaper taxi service would not be registered in the CPI measurement as a price fall for those that switched to it.

7.68 Alternatively, it might be considered that the new taxi service is so different from the existing one that it falls within a brand new elementary aggregate, but still within COICOP code 07.3.2—passenger transport by road. The new taxi service would have its own weight and be incorporated into the index by adding a new elementary aggregate and re-distributing the weight. Again, prices for two successive periods are required and this procedure precludes the CPI from taking into account any effective fall in price arising from the availability of a substitute effectively cheaper taxi service.

7.69 An appropriate treatment in this stylized example would be to treat the new taxi provider as a comparable replacement: the assumption is that the same quality of service is maintained. If this assumption is valid, the price fall is captured by the index.
7.70 The inclusion of new goods by the overlap method is, as outlined above, a normal part of CPI compilation being undertaken on re-basing, when new elementary aggregates are introduced and outlets and representative varieties for elementary aggregates within them, are reinitialized. Price changes of the “old” sample are measured up to and including the overlap period, say December 2020 for an annually-chained CPI, and then from December 2020 to include successive months in 2021, for the new sample. Were, for example, online shopping to be introduced into the CPI in the rebasing, from December 2020, the price relatives for December 2020 to January 2021 would include the price changes from online outlets, while that from November to December 2020 would exclude it. Were prices in online outlets cheaper than those in bricks-and-mortar stores, their price fall experienced by consumers switching their expenditure from one to the other would not be registered.

7.71 A further example would be from an “outcomes” approach to medical services. Say an outcome is to fix a medical problem and a new medical procedure makes this cheaper. The overlap method using the price change of the old procedure up to the introduction of the new, and then links-in the price change of the new. The prices of the old procedure may be constant in the months prior to the new method and the price changes as may those of the new procedure, albeit at a lower level.

7.72 The underlying measurement flaw is that while the fixed-basket is regularly updated to maintain the representativity of the CPI, it fails to reflect price change benefits due to switching to these new goods.

**Revolutionary truly novel new goods and welfare (utility) gains**

7.73 Revolutionary truly novel new goods might be introduced on rebasing or, if attracting a high share of expenditure, through sample augmentation. In both instances the overlap method while including the new good, would not effectively capture the benefits experienced by the consumer from its purchase.

7.74 The successful introduction of revolutionary truly novel new good leads to a welfare (utility) gain to consumers reflected in, and evidenced by, a switch in consumer expenditure to the new good. Consumers are better off as a result of their purchase of the new good. There is no pre-existing service flow for a quality adjustment to be made. The introduction of the new good as “added lines” through either sample augmentation or a new elementary aggregate on rebasing using the overlap method misses the welfare gain at the moment of entry of the new good. It is only when two successive prices are available that the revolutionary new good is included, and then it is too late to capture the welfare gain. Consider the case of a new good to be introduced into a CPI, say in period 3. A conceptually sound approach to its incorporation into the index is to impute its price for period 2, that is to estimate its (Hicks) reservation (or choke) price. This is the price that would drive the demand for the good down to zero in the period prior to its introduction. The fall in the reservation price in period 2 to the actual price in period 3 might be substantial, though neglected in the CPI measurement. The measured CPI would be biased upwards, in this welfare sense. An analogous approach applies to disappearing goods, where the reservation price for a good last appearing in period 1, is estimated for period 2. Further, delays in the
introduction of the new good into the CPI might well generate further bias. Typically, the price of a revolutionary good declines rapidly after introduction, so there would be an upwards bias in delaying its introduction, again to the detriment of the credibility of the CPI regarding what may well be high-profile goods. Exiting goods have the opposite welfare effect of new goods, and excluding the exiting goods welfare loss would result in a downwards biased CPI.

**Evolutionary and revolutionary goods: a continuum**

7.75 The introduction of evolutionary new goods differs from that of revolutionary new goods, because in the former case there is the possibility of being introduced as a continuation of an existing service flow. In this regard the possibility exists of linking it, with a quality adjustment, to the pre-existing technology. This would be the case for household appliances, for example, where the spin-speed, running-cost, reliability and other price-determining features are improved. This might be as a replacement for an existing representative model with an explicit quality adjustment or integrated into the dynamic sample of models of washing machines sold each month using a database, scanner or web-based, that includes the quality characteristics of the models. Chapters 6 and 10 outline the hedonic methodology and data requirements for integrating such new evolutionary goods into a CPI while avoiding the perhaps unrealistic assumptions implicit in the use of overlap linking-in of a new model that makes its use likely to misrepresent quality-adjusted price changes, as also outlined in chapter 6.

7.76 However, evolutionary new goods may combine both a continuing service and a "newness." Mobile phones, for example, were an evolutionary good in the sense that they continued the provision of a service provided by land-lines, but had a substantive revolutionary characteristic on introduction, their wireless mobility, and this defined their revolutionary newness. This service flow was further developed as the mobile phone became a platform for the extensive range of applications it is commonly used for. The introduction of mobile phones into the CPI at rebasing or through sample augmentation using the overlap method could not be justified as a simple continuation of an existing service. Similarly, color television was a continuation of a black-and-white service flow, but there is no simple metric of "more of the service flow" that could be used to encapsulate the switch-over to such a new service feature.

**Distinguishing between new elementary aggregates and new goods/products**

7.77 New elementary aggregates are introduced on rebasing using the overlap method. The distinction between introducing a new good on rebasing and the introduction of a new elementary aggregates should be made. For example, "charges for undertaking and other funeral services,” COICOP class 13.9.0, were newly introduced into a CPI on rebasing. Its inclusion in the CPI would neither be as a new revolutionary good providing a previously unavailable service to consumers nor as an evolutionary good providing a different, usually improved, existing service flow, for example at a lower price. It is simply an updating of the basket of products consumers typically purchased resulting from an increased expenditure
share over and above a threshold cut-off, meriting inclusion. There is neither a switch in consumers’ expenditure away from an existing good to a new variant nor a welfare gain from consumers purchasing a revolutionary truly novel good.

How to respond to limitations in the use of the overlap method regarding new goods

7.78 First and foremost, the overlap method when rebasing can be useful because of its virtues in updating the fixed basket, along with new weights, outlets, products, and representative varieties, and limitations. However, publicizing the incorporation of a new good – for example, a technological innovation - into the CPI at rebasing using the overlap method may mislead users who may be expecting a fall in prices due to a switch to the new good but find that while introduced into the index, price changes are not reflected as such.2 The overlap method would not provide a measure that could be explained in this manner. Simple statements to the effect that new goods are being incorporated into the CPI by use of the overlap method through either forced substitution, sample augmentation, sample rotation, and rebasing may damage the credibility of the CPI. An important response is transparency. To explain in the CPI dissemination publication that although the new goods are being introduced so that its future successive price changes are reflected in the CPI, the price changes from consumers switching from one to the other will not.

7.79 Given the practical problems in introducing revolutionary new goods into the CPI, a natural response for a NSO is to define a CPI to exclude the implicit price falls and welfare gains arising from the introduction of revolutionary new goods. “Welfare gains” and “reservation prices” are not considerations employed in the usual interpretation of CPIs. While there are studies on the estimation of such reservation prices, their practical use for CPI compilation is problematic.3

7.80 However, this is not to absolve statistical practice of a practical inability to include welfare gains. A reality of revolutionary new goods is that our standard of living increases and this increase, when matched against changes in our nominal income, implies a price fall. When the CPI for the product group concerned does not reflect this fall, a recognition and

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2 It may of course be the case that a price increase is expected with the introduction of the new good, but consumers are aware that the CPI measurement may mitigate this because of the effect of the quality innovation on this price increase.

explanation given in the CPIs methodological papers and “frequently asked questions” can but reinforce the credibility of the CPI. Revolutionary new goods, and evolutionary new goods whose main innovation is a revolutionary service, should be introduced through sample augmentation and rebasing in a timely manner with adequate explanation as to the limitation of the measure. The NSO is the honest transparent broker in such matters of measurement.

7.81 Second, within the range of evolutionary and revolutionary goods, CPI statisticians should identify evolutionary new goods whose main features are the extension of a pre-existing service flow, although they may result from a new technology, and using the techniques of explicit quality adjustment outlined in chapter 6, integrate the measures into the existing elementary aggregates. There should be a recognition of the different aspects of the evolutionary goods that would not be taken in to account and these would be documented and explained to the user, much in the manner that the shortcomings in the introduction of revolutionary goods.

7.82 Third, there may be specific instances where a relatively homogeneous service flow is still provided by the evolutionary good. For example, specific varieties/services may now be sold through online and/or through mobile applications. These may be cheaper and/or have better search facilities than would be possible using bricks-and-mortar stores. The introduction of such new outlets using an overlap method would not enable the effective price fall to be included in the CPI. Yet there is a different, quite positive, service aspect of buying some items at bricks-and-mortar location that are not available online. It is quite possible that the service through a bricks-and-mortar store is considered superior for some outlets/products. Again, the quality difference would not be reflected by simply linking-in an overlap price change.

7.83 However, were the purchases considered to be homogeneous, a unit value index would appropriately achieve this. When there is price variation for the same quality of good or service, the price relatives used for index number calculation should be defined as the ratio of the weighted average price of that good or service in the two periods, the weights being the relative quantities sold at each price, a unit value index. Suppose, for example, that a certain quantity of a particular good or service is sold at a lower price to a particular category of purchaser without any difference whatsoever in the nature of the good or service offered, location, timing or conditions of sale, or other factors. A subsequent increase in the proportion sold at the lower price lowers the average price paid by purchasers for quantities of a good or service whose quality is the same and remains unchanged, by assumption.

7.84 However, if the new good/service has a quality dimension different to the existing one, there is a dilemma. A judgement must be made as to the advantages of properly including the price fall, in the aforementioned example, resulting from the cheaper online purchasing, but not taking account of the other quality dimensions, as against simply introducing the outlet using the overlap method and ignoring effective decreases in average prices paid.
7.85 Of concern with the simple use of the overlap is that there is a distinct bias to the CPI as it overstates price inflation in ignoring the switch to cheaper prices. The benefits of the digital economy, in this respect, would be absent from the official statistics. CPI compilers would point to their integration of such outlets into the CPI sample, but this would only conceal the deficiency of the methodology; indeed, it might be argued that based on the CPI figures the new online outlets have no impact on consumer prices.

7.86 Yet the unit value’s assumption of homogeneity of consumer services in the two types of outlets may be argued to open up a higher level of bias, the nature of which will vary depending on the product considered. Analytical frameworks for unit value indices with quality adjustments have been developed with this problem in mind.4

7.87 The recommendation is to provide as part of the published metadata an audit of the maintenance of the sample. This would include statistics on the use of temporary and permanently missing varieties and their replacements, and the methods employed for their replacement, as outlined in chapter 6. Specific attention should be addressed to product areas where there is a high churn/expansion in model turnover and introduction of new goods, as outlined in this chapter.

7.88 The metadata should be further extended to include an audit of new goods that are believed to have a sufficient impact on the standard of living of households. The broad principles of how such new goods are treated and any practical limitations in such treatment should be highlighted. The inclusion of the goods should for the large part be focused on traditional criteria such as those product areas with relatively high (up-to-date) expenditure weights and to exclude free goods.5 The exclusion should not just be confined to expenditure weights but draw attention to relatively low expenditure new goods that are considered to be responsible for substantial increases in the standards of living. The document should be a living document updated regularly.

7.89 Impact studies and methodological developments are likely to have a cross-country relevance. It is likely to be the case that methodologies, and for that matter results, from single country studies can be applied more generally, or at least cited so that users have some indication of the impact of specific new goods. The Expert Group on Consumer Price Indices6 and the Ottawa Group on Price Indices7 may provide useful references for developments in such work.

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5 As discussed in Reinsdorf and Schryer (2017), *op.cit*.

6 The Expert Group on Consumer Price Indices is established by the Conference of European Statisticians. The meetings of the Group take place every second year, jointly organized by UNECE and ILO. The proceedings of the Expert Group meetings are available from the UNECE website, [www.unece.org/statistics](http://www.unece.org/statistics)
D. Information requirements for a strategy for the maintenance of the sample

7.90 It should be apparent from the above that a strategy for the maintenance of the sample must not only be linked to sample representativity, but also requires building a statistical metadata system. The approach for the index as a whole requires the continual development of market information and the recording and evaluation of the sample development on a product-by-product basis. The rationale for such a metadata system relates to the variety of procedures for quality adjustments to prices discussed in chapter 6 and how their suitability might vary on a case-by-case basis, all of which require documentation.

7.91 Metadata is systematic, descriptive information about data content and organization that helps those who operate the statistics production systems to remember what tasks they should perform and how they should perform them. Such data also serves to encourage transparency in the methods used and help ensure that they are understood and continued as staff members leave and others join. In the context of chapter 6, a variety of methods might be employed for the treatment of missing prices and their replacement including implicit and explicit approaches and, further, the detailed use and nature of these methods for particular product groups may change over time. Metadata may need to be updated regularly. Such a monitoring system should serve to alleviate the monthly degradation of the price reference period sample for each product group. The term “metadata” is use here to include this aspect of quality assurance.

7.92 An aim of the metadata, as proposed in this context, is to help identify in which product groups the sample is deteriorating and how it might be replenished. This applies not only to the static sample selected at the last rebasing, to counter its degradation by use of appropriate replacements when variety prices go missing. But also, to ensure the static sample remains representative of the universe of transaction and is not biased against the introduction of new varieties of products, and new products themselves.

7.93 The metadata should monitor and document the extent of temporarily and permanently missing prices and methods used for quality-adjusted prices. Price indices for specific goods, such as personal computers, may be derived using specific compilation/estimation routines and metadata is required to document such procedures. Because so much of the rationale for the employment of different methods of treating missing variety prices and quality changes is specific to the features of the product groups concerned, information is required on such features. This would extend to maintaining data on market features, such as the dates for the introduction of new goods and the nature of their technological change. An eye has to be kept on out-of-sample developments, that is outside the static sample: the obsolescence of existing goods and emergence of new goods onto the

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7 The Ottawa Group is a city group set up in 1994 under the auspices of the United Nations Statistical Commission. It is dedicated to methodological work and applied research in consumer price indices and other price statistics and provides a forum for specialists and practitioners who work for or advise national statistical offices or international organizations to exchange experiences and thoughts. Information about the Ottawa Group and proceedings from its meetings are available from the Group’s website, [www.ottawagroup.org](http://www.ottawagroup.org)
market. New technologies, products, a proliferation of new varieties of products, accompanied by emerging brands may become responsible for a major part of the market. To increase transparency in the procedures used and allow effort to be directed where it is most needed:

- NSOs should monitor the incidence of temporarily and permanently missing variety prices at a say two-digit Classification of Individual Consumption According to Purpose (COICOP) level, as appropriate, and if the incidence is high for a particular product group, at the three- or four-digit level. The advantage of a top-down approach is that resources are saved by monitoring at the detailed level only those product groups that are problematic.

- The ratios of temporary missing prices, comparable replacements, and non-comparable replacements to the overall number of variety prices, and the methods for dealing with each of these three circumstances, should also be monitored. Against each product group, the weight of the product concerned should be listed so that a disproportionate effort is not given to relatively low-weighted products.

- The metadata system should be directed to the periodic monitoring, preferably on a monthly/quarterly basis, of the methods used for treating temporarily and permanently missing prices as proposed in chapter 6.

- Such metadata should extend to the NSOs desk officers developing market expertise on selected high-profile, heavily-weighted product groups where the consumer goods and services provided are sufficiently complex to impose on the measurement system the need for special consideration: product groups such as telecommunications, computers and computer-related hardware and software, electronics, property and rentals, goods sold over the internet, and so forth, as outlined in chapter 11.

- The metadata might also include:
  - Product-specific information, such as the timing of the introduction of new models, pricing policies, especially in months when no changes were made, and popularity of models and brands according to different data sources.
  - Information arising from contacts with market research organizations, retailers, manufacturers, and trade associations for products for which replacement levels are high. The development of such contacts may lead, for example, to option cost estimates, which can be easily introduced. Where possible, staff should be encouraged to learn more about specific product groups whose weights are relatively high and where product replacement is common. Contacts with organizations in such product groups will allow staff to better judge the validity of the assumptions underlying implicit quality adjustments.
  - Product groups likely to be undergoing regular technological change should be identified. The system should attempt to ascertain the pace at which models change and, where possible, the timing.
- Price-determining characteristics for products undergoing technological change, especially if quality adjustment procedures make use of hedonic regressions. Information may be included from market research organizations, responding businesses, wholesalers, trade associations and other such bodies. This should contribute to the statistical metadata system and be particularly useful in providing subsequent guidelines on product selection.

- The system should undertake an analysis of what have in the past been judged to be “comparable” replacements in terms of the factors that distinguish the replacement and old product. The analysis should identify whether different price collectors are making similar judgments and whether such judgments are reasonable.

- When hedonic regressions are used either for partial patching of missing prices or as indices in their own right, information on the specification, estimated parameters, and diagnostic tests of the regression equations should be kept along with notes as to why the final formulation was chosen and used along with the data.

- A systematic strategy for the use of alternative data sources for prices and weights including scanner data, web-based prices, monthly billing statements, and methodologies and software for their use, as necessary. Such alternative sources are likely to directly benefit the maintenance of the representativity of a sample especially insofar as there is a movement away from the static sample of MMM.

While these metadata reflect best practice, developing such detailed and comprehensive metadata require significant resources. NSOs should begin developing detailed metadata on the incidence of temporarily and permanently missing prices. Understanding which items and varieties are missing, the duration the prices are missing, and why these prices are missing will serve as the first step for maintaining the sample. As resources permit, a plan to develop additional metadata over time can be developed and implemented.