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The Canadian Consumer Price Index Reference Paper

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Preface

This *Canadian Consumer Price Index (CPI) Reference Paper* provides an overview of the Canadian CPI. It is intended for a varied audience, ranging from users interested in general information to those requiring more technical or theoretical details. As such, it explains all the important aspects of the Canadian CPI: uses and interpretations, scope, classifications, sample strategy, price collection, index calculation, quality change, weights, basket updates, reliability and uncertainty, special cases and treatments and history.

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Reader's Guide

This volume explains the conceptual, structural and methodological basis of the Canadian Consumer Price Index (CPI). It should be regarded as an update to *The Canadian Consumer Price Index Reference Paper*, published in 2019.[1] It provides a thorough explanation of the concepts and methodology underlying Canada's CPI. The first chapter provides an overview and summary of the entire document.

1. Statistics Canada (2019).

Chapter 1 – Introduction to the Canadian Consumer Price Index

1.1 The Canadian Consumer Price Index (CPI) is an indicator of the change in consumer prices. It measures price change by comparing through time the cost of a fixed basket of consumer goods and services. Since the basket contains products of unchanging or equivalent quantity and quality, the index reflects only "pure" price change".

Availability and Uses

1.2 The CPI is released every month, about three weeks after the price observation period. A variety of CPI time series for different product classes and geographical areas are available without charge on the Statistics Canada Website.[2]

1.3 The index is used for an assortment of different purposes by various users. One of its most important uses is by governments, businesses and individuals to adjust selected contractual or legislated payments in line with inflation. By linking a stream of future payments to the CPI, it is possible to ensure the purchasing power represented by those payments is unaffected by the average change in consumer prices that may occur.[3]

1.4 Since 1991, the Bank of Canada and the Government of Canada jointly established an inflation-targeting framework for the conduct of monetary policy. Based on this framework, the Bank of Canada conducts monetary policy aimed at keeping inflation, as measured by the change in the all-items CPI, at 2%, the midpoint of an inflation-control range of 1 to 3%. To help it achieve this target, the Bank of Canada uses a set of measures of core inflation.[4] The purpose of these measures is to capture persistent price movements by eliminating transitory or sector-specific fluctuations in some components of the CPI.

1.5 The CPI is regularly and widely reported by the news media and is the standard measure of inflation used by most Canadians.

1.6 The CPI itself compares prices in the current month, t, to prices in the index reference period, where the index is set arbitrarily to 100. For many purposes it is also useful to calculate month-over-month changes or 12-month changes, comparing prices in the current month to those in the immediately previous month or the same month one year earlier. Contributions to percentage change are also useful for the analysis of price change because they provide the influence of changes in sub-aggregate indices to changes in aggregate indices. In Statistics Canada's CPI publications, all indices and percentage changes are rounded to one decimal place.

1.7 For more details on the availability and uses of the Canadian CPI, and on the interpretation of percentage changes and contributions to change in the CPI and the effect of statistical rounding on the index, refer to Chapter 2.

2. The Statistics Canada Internet site is www.statcan.gc.ca. Regularly updated information on the CPI is available on the Consumer Price Index portal.
3. Among the many such indexed payments are those from Old Age Security, the Guaranteed Income Supplement, real return federal and provincial bonds and a variety of private financial arrangements such as some spousal and child support allowances, negotiated wage agreements and longer-term rental contracts.
4. From 2001 until October 2016, the Bank of Canada's focal measure of core inflation was the all-items CPI excluding eight of its most volatile components (as defined by the Bank of Canada) as well as the effect of changes in indirect taxes on the remaining components (CPIX). Since October 2016, the Bank has identified three preferred measures of core inflation to help assess underlying inflation: i) a measure based on the trimmed mean (CPI-trim); ii) a measure based on the weighted median (CPI-median); and, iii) a measure based on the common component (CPI-common). While the Bank's emphasis is on these three measures, Statistics Canada continues to calculate and publish CPIX.

Scope of the Index

1.8 The CPI does not purport to measure the average movement of prices for all products bought and sold in Canada. Rather, its scope is limited to the prices of goods and services purchased by Canadian households in Canada. Moreover, the purchases of most, but not all households are in scope. The few exceptions include soldiers on military bases, people living on First Nations reserves, and institutionalized persons, such as prison inmates and persons in long-term care facilities. In addition, households living in the rural areas of the three northern territories, outside Yellowknife, Whitehorse and Iqaluit, are deemed out of scope due to the difficulty and cost of monitoring prices in these remote regions.

1.9 Many products are out of scope for the CPI. For example, the prices of raw materials and other intermediate products purchased by manufacturers as inputs to their production processes are not included. Nor are the prices paid by governments for office equipment, consulting services and other products. Likewise the prices paid by businesses in other countries for exported Canadian goods and services are excluded. The CPI refers to the prices paid by Canadian households for consumer goods and services.

1.10 Financial products such as equities and bonds are not included either, even though they might be purchased by consumers, since they are considered financial investments rather than consumer goods or services. Nevertheless, the prices of the services that facilitate the purchase of such financial assets, such as banking and brokerage charges, are in scope. Illegal products, such as certain types of non-prescription narcotic drugs, and a few legal products such as gambling services are also excluded, because of the practical or conceptual difficulties they present.

1.11 The CPI aims to measure average transaction prices throughout the entire reference month. Prices reflected in the index are those actually paid by Canadians to purchase consumer goods and services,[5] including the impact of any discounts or sales and excise taxes that may apply, such as the Goods and Services Tax. Accordingly when tax rules or rates change, the index is affected. The index does not include personal income taxes because these are not associated with the purchase of any particular product.

1.12 Chapter 3 provides a more thorough explanation of the CPI scope.

Classifications

1.13 The CPI covers a wide range of goods and services and a large geographical area. It does this by using classifications of products and geography. The product classification is periodically reviewed and updated and typically contains over 500 product classes that together account for all products in scope for the CPI calculation. The geographical classification has 19 area strata representing the ten provinces, with four in Ontario, three in Quebec, two in British Columbia and one in each of the others, plus the Primary Census Agglomeration (PCAs) of Yellowknife, Whitehorse and Iqaluit. The CPI is built up from price indices for elementary aggregates, which are pairings of product and geography classes from these two classifications. For more information about the product and geography classifications and the associated elementary aggregates, see Chapter 4.

Sample Strategy

1.14 Households engage in millions of transactions every month. Most of the prices involved in these transactions are in scope for the CPI. However, since it is challenging to observe the prices in all transactions, a statistical sampling approach is required. That approach involves a general sampling strategy for most prices combined with more specialized strategies for some specific product classes. General sampling for the CPI occurs in three stages.

1.15 In the first stage, a set of representative geographical collection areas is selected, first in terms of census subdivisions (CSDs) (which are essentially municipalities) and then in terms of specific census tracts within the chosen subdivisions (which are like neighbourhoods within municipalities). The sampling of census subdivisions and tracts is done with population counts serving as weights.

5. In many cases, the CPI relies on list prices as this is the only price information available to the CPI price collection agents.

1.16 The second stage is the selection of representative outlets from the CPI outlet frame. The degree of "representativeness" of outlets is assessed using a variable such as annual sales revenue.

1.17 In the third stage a set of representative products (RP)[6] from each of the product classes is chosen to characterize all the products in that class and to be collected in the outlets selected at the second stage. The product sample is not probabilistic because there is no comprehensive sampling frame for all consumer transactions.

1.18 At the outlet sampling stage, the goal is to identify sales by product class by type of outlet (large retail stores, small retail stores, Internet sales, and so on), in order to identify which types of outlets account for the largest proportion of consumer purchases. That done, specific outlets can be selected in which to observe the prices of specific RPs. For a few product classes, where national or provincial pricing predominates, prices are collected centrally at headquarters via the retailer or service provider's websites with no reference to specific retail stores. However, in most instances prices are obtained by price collection agents through local retail stores' websites.

1.19 From each product class a small sample of RPs is chosen to characterize all the products in that class. Ideally the selection of RPs would be chosen probabilistically, with associated weights reflecting the relative importance of each product within the class. This would require a products "frame" – a comprehensive and up-to-date list of products with associated expenditure values of collected prices. Frame information of this kind is available for a few selected product classes, but is presently unavailable for most product classes. For this reason, the selection of RPs for most product classes is done judgmentally, with emphasis on products that are known to be among the most popular with consumers.

1.20 For a few product classes, no sampling is required because it is possible to observe all transaction prices for the entire product class. This is substantially the case for passports, passenger vehicle permits and driver's licenses. Cut-off sampling is used in some instances. The profiles method is used where the market normally prices product bundles instead of individual products and the bestsellers method is used for products where prices are based on intangible characteristics, such as novelty of the content, as well as for prices collected from some online retailers.

1.21 The sample size is limited by budgetary considerations. Given a particular sample size, the optimal allocation of sample across product/outlet pairs is a challenge. Key factors entering into decisions about this allocation are the volatility of the product price, the basket weight for the product class in question and the associated collection cost. The more volatile a product's price, the greater its basket weight and the lower the marginal cost of price quote collection, the larger will be the price sample for that product category.

1.22 Chapter 5 provides more details on the sampling strategy for the CPI.

Price Collection

1.23 Most of the price quotes used to calculate the CPI are collected in the sampled outlets in various locations across the country. The collection is done by employees, known as price collection agents, supervised by the Statistics Canada Regional Offices. Each month Statistics Canada headquarters sends a sample request to the price collection agents, who collect the requested price quotes, record them in Computer-Assisted Personal Interview (CAPI) devices and transmit the data to headquarters in Ottawa for further processing.

1.24 For some outlets, no price collection by price collection agents is needed as Statistics Canada receives data files from retailers containing revenues/sales and quantities sold for each product based on all point of sale transactions for the entire week. These files are provided to Statistics Canada by retailers operating in Canada. Statistics Canada also relies on price and product characteristics data collected from Web sites as well as from application programming interfaces (APIs) used to observe prices on the Internet (e.g. for air transportation, and clothing and footwear).

6. A list of all representative products (RP) used in the Canadian CPI is available at "The Representative Products of the Consumer Price Index".

1.25 For some CPI components, such as mortgage interest cost, purchase of new passenger vehicles, purchase of used passenger vehicles, leasing of passenger vehicles, gasoline, passenger vehicle insurance premiums or homeowners' home insurance premiums, Statistics Canada relies on administrative data to estimate the price movements, so there is no price collection by price collection agents for these. These administrative datasets offer a better coverage of the product range generally purchased by consumers than traditional collection by price collection agents.

1.26 Back at headquarters, the observed prices are reviewed for conformity with the sample request, checked for unusual or 'outlier' values and corrected if necessary, adjusted for quality changes where appropriate (as explained in Chapter 7) and generally made ready for the CPI calculation.

1.27 or more about the price data and data processing procedures, see Chapters 5 and 7.

Calculation of the Consumer Price Index

1.28 The calculation of the CPI is done in two steps. The first, termed the lower level calculation, generally involves calculating price relatives, using a matched-model approach, and then averaging them together to obtain elementary price indices. Different approaches to the lower level calculation are used in a few special cases such as the computer equipment, software et supplies index, used vehicles and the rent index. The second step, referred to as the upper level calculation, involves the estimation of aggregate price indices as weighted averages of the elementary price indices.

1.29 The lower level calculations are mostly done using an implicitly weighted geometric mean equation, referred to as the Jevons formula. There are some exceptional cases, however, where alternative formulas are used. Some of the more significant among these special cases are the elementary product classes for mortgage interest charges (explained in Chapter 10), dwelling rents, property and automobile insurance, banking services and post-secondary education services (see Chapter 6).

1.30 The upper level calculations are done using a fixed-basket Lowe formula, which applies fixed quantity weights to the elementary price indices in order to aggregate them. The basket weights determine the relative importance of different product classes and geographical regions in the all-items CPI.

1.31 The structure and methodology of the CPI are technically complex and the summary just given omits many details. A fuller description is provided in Chapter 6. In addition, the mathematical formulas for the aggregation of the CPI are listed in the appendix.

Quality Change and Adjustment

1.32 The CPI aims to measure 'pure' price change and it does this via the 'matched-model' approach to sampling. However, what happens when a given sampled product is no longer carried by a particular outlet, or when the outlet in which the product's price is collected has closed its doors? In these kinds of situations, a substitute product or a replacement outlet must be chosen and price change in the affected month must be adjusted for any quality difference that may exist between the new and the old products.

1.33 Adjustments for quality change are often fraught with difficulty and pose a demanding challenge for index compilers. A variety of different methods are employed depending on the circumstances.

1.34 For some products there is no significant possibility of quality change and for these, no adjustments are needed. Examples include products like electricity, natural gas or gasoline. For some packaged products, the quality is unlikely to change significantly but the quantity in the container may increase or decrease. When this happens, the observed price change is adjusted to standardize for quantity. Examples of this standardization treatment include cereals, laundry detergents and candy bars. The most difficult cases of quality adjustment involve such products as automobiles, high-tech goods, items of clothing and many types of services. These products involve more substantial changes in the inherent quality of the product over time as a result of technological innovation, changes in fashion or other factors.

1.35 A thorough discussion of how quality change is dealt with in the CPI is provided in Chapter 7. As explained there, a variety of methods are used for the various product classes. Among these are implicit techniques, such as direct price comparison, overlap pricing, overall mean imputation, and link-to-show-no-change. Where implicit adjustment is not feasible, various explicit quality adjustment methods, including hedonic modeling, option cost method and expert judgment are used.

Weights and Basket Updates

1.36 The product and geographical classifications, discussed in Chapter 4, are important to many aspects of the CPI. They offer users of the index considerable detail that is helpful in analyzing inflationary trends. They provide a foundation for the price sampling strategy, as discussed in Chapter 5. In addition, they are central to the "fixed basket" concept that underlies the CPI upper level calculation.

1.37 To grasp the fixed basket concept consider the following story. A person enters a store, fills a shopping basket with various products and pays for these items at the cash register. The following month the person goes back to that store and buys the exact same quantities of the same goods and services. In other words, the person buys a "fixed basket" of goods and services. The cost of the products bought in the second month divided by the cost of the identical items purchased in the first month is an aggregate price relative. Defining a price index starting value of 100 in the first month, the price index will change in the second month to 100 multiplied by the aggregate price relative just computed. This is what is meant by a fixed basket concept. The CPI is essentially a fixed basket index of this type, except that the CPI "basket" contains not just a few specific products, but rather all the in-scope goods and services purchased by households in Canada.

1.38 Each of the elementary classes has a fixed quantity weight that is used as part of the CPI aggregation process – that is, to combine the elementary price indices into the all-items CPI. However, data on consumer expenditures is much easier to obtain than data on quantities purchased. Since the Lowe formula can be expressed in terms of quantities, expenditures or expenditure shares, the aggregate expenditure for each elementary class is used. These expenditures are a product of the unobserved quantities and the observed prices. In order to maintain the fixed quantity nature of the index, the expenditures used in the calculation have to be price-updated according to observed price changes.

1.39 The CPI expenditure weights are estimated primarily from the most recent Household Final Consumption Expenditure (HFCE) data, and supplemented by data from the Survey of Household Spending (SHS). Additional data sources are used to better inform expenditure weights for specific aggregates, or where HFCE or SHS data were unavailable. These data sources are typically used to obtain statistical estimates of household expenditure by product class and region. Of course, household expenditure patterns are in constant flux in response to demographic change, the economic cycle, shifting relative prices and other factors. The current practice is to measure the household expenditure weights comprehensively for a 12-month period, and to refresh these estimates as frequently as possible. When the weights are recalculated in this way, the process is referred to as a "basket update".

1.40 The CPI is a sequence of fixed basket indices, each with its own unique classification structure and basket weights, which have been chain linked together. As of the 2021 basket introduced in the CPI calculation in June 2022 for the May 2022 CPI basket updates occur every year, but in the past it was carried out less frequently. The more-than-100-year time series for the CPI, which is available on Statistics Canada's website, is really a chain-linked series of many CPIs.

1.41 It is important to distinguish between the weight reference period, the index reference period and the price reference period. The first of these is the period from which the CPI expenditure weights are taken. The index reference period is the period in which the index is arbitrarily scaled to equal 100. Currently, for the Canadian CPI this is 2002. The choice of index reference period has no effect on percentage changes in the index. Users can easily change the index reference period by simply rescaling the index accordingly. Finally, the price reference period is the period that prices are being compared with. It appears in the denominator of price ratios and is typically designated as period 0.

1.42 Chapter 4 provides a more thorough discussion of the CPI classification systems, while Chapter 8 focuses on the weights and basket updates as well as the index reference period.

Reliability and Uncertainty

1.43 Statistical error is, of course, the difference between the unknown "true" value and the measured value. The CPI is, for the most part, a sample-based statistic, and like all such statistics, is subject to several types of error. The error can occur either during the lower level calculations or as part of the upper level calculations.

1.44 Statistical bias arises when the average expected result over many samples differs from the "true" value. In the case of the CPI, bias can occur for several reasons. When statisticians need to replace one product with another and they make an associated quality adjustment, statistical bias might be introduced if the method for doing so had a persistent tendency either to underestimate or to overestimate the true extent of quality change. Bias might also be inherent in some editing procedures, although, of course, Statistics Canada strives to avoid any such bias.

1.45 Sources of potential bias are associated with new product introductions and outlet substitutions. New product introduction bias occurs when innovative products appear on the market and are not reflected in the CPI product sample in a timely manner. A number of steps are taken to guard against this bias, but it is difficult to avoid entirely, especially given the CPI's matched-model pricing methodology. Outlet substitution bias occurs when new stores enter the market offering lower prices or new types of services and thereby inducing consumers to switch outlets. Again this is a difficult source of potential bias to avoid completely, but efforts are made to refresh the outlet sample periodically to minimize this kind of bias.

1.46 Sampling variance is an error characteristic that is very different from statistical bias. It refers to the extent of dispersion of estimates, over many samples, around the "true" value. In a statistical context, larger samples will yield lower variance. Efficient statistical estimation means minimal variance given the sample size. It is quite possible to have a zero bias and a positive variance. However, the only way to achieve a zero sampling variance is to measure the entire target population which, in the case of the CPI, is not possible.

1.47 Most Statistics Canada surveys report numerical estimates of the size of the sampling variance. These provide users of the statistics with an indication of statistical reliability. Thus, when a particular statistical estimate is released, the variance might be used to calculate what the "true" value is expected to be within certain specific numerical boundaries 19 times out of 20. As explained in Chapter 5, however, this is not possible for the CPI because the product sampling is almost always done judgmentally rather than randomly.

1.48 The CPI may also be subject to non-sampling errors of various kinds. Clerical and transcription errors fall into this category, although there are a number of checks and balances in the CPI monthly production process that aim to detect and correct any such errors. Another source of non-sampling error is errors and omissions in the business frame (list) that is used in selecting the sample of outlets for price collection by price collection agents. Again, efforts are made to minimize such errors, but it is nearly impossible to keep the list of retail businesses constantly up to date and without error.

1.49 Another notable source of potential error in the CPI applies to the elementary aggregates that are estimated by imputation rather than by direct price measurement. There are several residual classes in the CPI product classification, typically containing a wide variety of distinct goods and services, yet having comparatively small basket weights. Price change for these elementary aggregates is estimated indirectly, by imputation, as a cost-saving measure. The expense of direct price measurement in these cases would be unjustified given their small basket weights and heterogeneous character.

1.50 Prices change with the passage of time and as they do, consumers tend to substitute goods and services that have become relatively cheaper for ones that have become relatively more expensive. For example, if pork prices have risen less rapidly than beef prices, there is an incentive for consumers to buy more pork and less beef. This phenomenon tends to make the basket weights out of date as time goes by. It causes a problem called substitution bias that influences the CPI upper level calculation.

1.51 Ideally the basket weights would reflect purchasing patterns of consumers in both periods for which prices are being compared. In other words, if the index is comparing two particular months, the weights would reflect the purchasing patterns of consumers in those two months. This is not presently feasible. In fact, the weights come not from the two months where prices are compared, but from some period (typically a year) prior to the price reference period (0) and price observation period (t). This is the main source of substitution bias in the CPI. Normally the closer is the time period from which the weights are calculated to the two months being compared, the smaller will be this source of bias. In 2013, Statistics Canada increased the frequency with which the basket weights are updated from once every four years to once every two years, which reduced substitution bias. This bias is likely further reduced as a result of the decision made in to update the basket weights every year starting with the 2021 basket update implemented in 2022.

1.52 In addition, the upper level calculations are affected by statistical error in the SHS as well as in the Canadian System of National Accounts' (CSNA) estimates of HFCE, which are used to estimate thebasket weights.

1.53 Chapter 9 provides a much fuller discussion of the CPI's reliability, error properties and statistical bias.

Treatment of Owned Accommodation

1.54 Owned accommodation is an important component of the CPI, with a large basket weight, which poses especially difficult conceptual and methodological issues. There is no international consensus on how best to define and measure the price of owned accommodation and countries have adopted a variety of approaches. This makes international comparisons of inflation challenging.

1.55 The difficulty in this case stems from the fact that owned accommodation can, for some purposes, be thought of as a capital good rather than consumption good. Like all capital goods, it provides a stream of services over a lengthy period of time. Statistics Canada's approach is to measure the impact of price changes on the costs incurred by homeowners while they own a home. These costs include mortgage interest, replacement cost (depreciation), property taxes, home and mortgage insurance, maintenance and repairs, and other expenses. The first three of these cost categories account for almost two thirds of the total owned accommodation basket weight.

1.56 The owned accommodation price index is explained in Chapter 10.

Seasonal Products

1.57 Some of the products whose prices are measured by the CPI are highly seasonal, both in terms of the quantities purchased each month by consumers and in terms of the prices retailers charge at different times during the year. This is true for fresh fruit and vegetables, some kinds of clothing and certain recreational services, for example.

1.58 The basket weights applicable to seasonal products are, just as for non-seasonal products, estimated using annual household expenditure statistics. They are, therefore, not seasonal even though the monthly purchases by consumers can vary considerably through the year. Indeed, for some products in some months consumer purchases are zero – Christmas trees in July, for example. Statistics Canada deals with such cases by imputing the price movement based on that of similar in-season products. The fact that actual purchases of seasonal products in a given month can be very different from the purchases that are reflected in the yearly basket weights is another source of statistical bias in the CPI. This bias is likely to average near zero for the year as a whole, but can be significant in month-over-month comparisons. Bias is discussed in Chapter 9.

1.59 A related matter is the fact that monthly changes can be substantially influenced by seasonal factors. For any given month-over-month percentage change, users of the index often find it advantageous to distinguish between the part that is attributable to normal seasonal causes and the remaining non-seasonal part. The seasonal part is predictable and, therefore, less interesting. The non-seasonal part reflects the underlying trend in prices as well as any special temporary factors, and is more indicative of underlying contributing factors.

1.60 Seasonally adjusted indices reflect price change after seasonal fluctuations are removed. Statistics Canada provides seasonally adjusted versions for the all-items CPI, the eight major aggregates and six of the special aggregates. These indices are seasonally adjusted independently, which implies they are not consistent in aggregation; in addition, these indices are subject to revision over time, mainly due to revisions in estimated seasonal factors, unlike the non-seasonally adjusted indices which are not revised.

1.61 The influence of seasonality on the CPI is discussed in Chapter 10.

History of the Canadian Consumer Price Index

1.62 Canada's CPI has a century-long history. The index has been improved greatly over that lengthy period. The interval between basket changes was reduced in several steps, from 13 years the first time the basket was updated in 1926 to just every year since 2022. The estimates of the basket weights were much enhanced by the introduction of the Family Expenditure Survey for the year 1938. The scope of the index has been broadened several times, in a number of ways. The sample size has risen, fallen and risen again, reflecting changing budgetary priorities. In addition, while the index was often revised during its first few decades, starting with the postwar period, the policy has been to eschew statistical revisions of the raw, seasonally unadjusted statistics, as a convenience to users.

1.63 For more on the history of Canada's CPI, see Chapter 11.

Chapter 2 – Availability and Uses

Availability of Information

2.1 The all-items Consumer Price Index (CPI), various aggregate indices as well as special aggregate indices are produced and published each month for Canada, the provinces, Whitehorse and Yellowknife. Additionally, the all-items CPI and the shelter price index are produced and published for sixteen cities.[7] The all-items CPI is the only index published for Iqaluit.

2.2 The CPI series for the eight major aggregates at the Canada level are also available seasonally adjusted. Each year with the release of the December CPI in January, annual average indices are produced for all of the published monthly indices. Annual average indices are calculated as the unweighted arithmetic average of the 12 monthly indices within the year. The monthly and annual average indices for the all-items CPI for Canada are available in chain-linked series back to 1914. Indices for other geographies and/or aggregates are available starting from various periods as they entered the CPI statistical program.

2.3 In addition to the monthly and annual CPI series, average retail prices (not price indices) for food and other selected items for Canada and for the ten provinces, and average retail gasoline and fuel oil prices for eighteen cities[8] are estimated and published monthly.

2.4 All monthly CPI statistics are available at 8:30 am EST on the day of the release. The release is typically on the third week of the month following the price observation period. For example, the CPI for price observation period November 2018 was released on December 19th 2018.

2.5 At present, there are two main vehicles for the release of the CPI data:

2.5.1 The Statistics Canada Website[9]

2.5.2 *The Daily*[10]

The Consumer price index portal offers information relating to all CPI data, publications, interactive tools, and announcements highlighting new products and upcoming changes to the CPI in one convenient location.

2.6 *The Daily* is Statistics Canada's main release bulletin and the Agency's first line of communication with the media and the public. The Daily provides an overview of the monthly CPI statistics while focusing on the indices which had the most notable upward or downward contributions to the year-over-year (12-month) and monthly percentage changes in the CPI.

2.7 Once published, the official CPI statistics are not revised. Seasonally adjusted price indices are the only CPI series which are revised. Those data are revised one month after release and then each year with the January CPI, the past 36 months of seasonally adjusted data are revised.

2.8 Contrary to the official CPI, the three Bank of Canada's preferred measures of core inflation, CPI-trim, CPI-median and CPI-common, are subject to revision. For CPI-median and CPI-trim, this results from the fact that these measures are based on seasonally adjusted price index series. For CPI-common, revisions are due to the statistical technique used as a factor model is estimated over all available historical data.

Interpreting Percentage Changes

2.9 The CPI is a composite price index, which compares prices for consumer products in various price observation periods (which can be months or years), to prices in the index base period (also referred to as the index reference period). The CPI is arbitrarily set to equal 100 in the index base period. Therefore, all index values express price change in percentage terms in comparison to the index base period. For example, if the index is 123.4, that means prices have increased 23.4% since the base period. The current index base period of the CPI is 2002.

7. The sixteen cities are: St. John's, Charlottetown-Summerside, Halifax, Saint John, Québec, Montréal, Ottawa, Toronto, Thunder Bay, Winnipeg, Regina, Saskatoon, Edmonton, Calgary, Vancouver and Victoria.
8. The eighteen cities include the previous sixteen cities plus Whitehorse and Yellowknife.
9. Statistics Canada, refer to data tables 18-10-0001-01, 18-10-0002-01, 18-10-0003-01, 18-10-0004-01, 18-10-0005-01, 18-10-0006-01 and 18-10-0256-01 (formerly CANSIM 326-0009, 326-0012, 326-0020, 326-0021, 326-0022 and 326-0023 respectively).
10. Statistics Canada, *The Daily*, Catalogue No. 11-001E.

2.10 The CPI base period can easily be changed by multiplying all CPI series by a constant conversion factor equal to 100 divided by the average index for another specific time period. This is known as rebasing an index. Period to period, price change will not be impacted by rebasing an index.[11]

2.11 Other common time comparisons that are made with the CPI include:

2.11.1 month-over-month percentage changes which compare price indices in a given month to price indices in the preceding month (e.g. November compared to October).

2.11.2 year-over-year (12-month) percentage changes, which compare price indices in a given month to price indices in the same month of the preceding year (e.g. November 2012 compared to November 2011).

2.11.3 annual average percentage changes, which compare two consecutive annual average price indices.

2.12 Special aggregate indices are calculated and published monthly and on an annual basis for Canada, the provinces, Whitehorse and Yellowknife.

2.13 Special aggregates are different combinations of elementary aggregates. They often exclude certain product classes, in order to provide users with supplementary information on how consumer prices are changing. These indices provide alternative measures of consumer price inflation.

2.14 When a special aggregate index excludes certain product classes, their corresponding weights are removed from the total. As a result, the shares of the remaining goods and services increase in relative importance.

2.15 The Bank of Canada's preferred measures of core inflation (CPI-trim, CPI-median and CPI-common) are based on the disaggregation of the all-items CPI into 55 exhaustive and mutually exclusive components.[12] The CPI-trim measure excludes CPI components whose rates of change in a given month are located in the tails of the distribution of price changes. This measure helps filter out extreme price movements that might be caused by factors specific to certain components. In particular, CPI-trim excludes 20% of the monthly variations in weighted prices at both the bottom and top of the distribution of price changes, and thus it always removes 40% of the total CPI basket. The components excluded from the CPI-trim calculation can change from month-to-month, depending on which ones are extreme in a given month. This approach differs from traditional a priori exclusion-based measures which, every month, omit a pre-specified list of CPI components. The CPI-median measure corresponds to the price change located at the 50th percentile (in terms of the CPI basket weights) of the distribution of price changes in a given month. This measure helps filter out extreme price movements specific to certain components. This approach is similar to CPI-trim as it eliminates all the monthly variations in weighted prices at both the bottom and the top of the distribution of price changes in any given month, except the price change for the component that is the midpoint of that distribution. The CPI-common measure tracks common price changes across categories in the CPI basket.

Rounding in the Consumer Price Index

2.16 During the different steps of their construction all CPI indices are calculated to several decimal places. However, consistent with international practice, indices are rounded to one decimal place when they are published. Percentage changes (monthly, 12-month and annual average) in Statistics Canada publications are always calculated with the published rounded indices. They are also rounded to one decimal place. That way, users can always replicate the published percentage changes.

2.17 As a result of these two stages of rounding, a small amount of accuracy in percentage changes may be lost. Therefore, small fluctuations (+/- 0.1) in the percentage changes of indices should be interpreted with discretion.

11. However published, percent changes may differ due to rounding.
12. The price indices of the 55 components are first adjusted to remove the effect of changes in indirect taxes. For more details on the Bank of Canada's preferred measures of core inflation methods and calculation.

2.18 Another side effect of rounding indices is that at times there could appear to be inconsistencies between the percentage changes in aggregate indices and their sub-aggregate indices. For example, the rounded percentage change of an aggregate index may not be centred among the rounded percentage changes of its sub-aggregate indices.

2.19 The loss of precision due to rounding is amplified when indices are of small value. Therefore, rebasing an index, which generally results in smaller index values for the past, can reduce the precision of calculated percentage changes. For example, with an index base period of 1914=100, a 0.1 percent increase in the all-items CPI from 1914 to 1915 would translate to an index value of 100.100, rounded to 100.1. However, with an index base period of 2002=100, the rebased 1914 index value would be 6.0. The same 0.1 percent increase in the all-items CPI from 1914 to 1915 translates to an index value of 6.006, rounded to 6.0.

2.20 Therefore, rounding indices reduces the precision for percentage changes for periods in the past. Loss of precision in historical figures should be considered when deciding to rebase an index.

Uses of the Consumer Price Index

2.21 The CPI, as a composite price index, is an official measure of consumer price change through time. It is of interest to governments, unions, business organizations, research institutions and very large segments of the general public. Undoubtedly, the CPI is one of the most widely known, quoted and used statistical series in Canada. Its prominent profile, while indicative of wide acceptance, also poses problems because the CPI cannot serve all uses perfectly and equally well. Users are advised, therefore, to approach the CPI with discretion, especially when using it for purposes that lie outside of its main focus.

2.22 The CPI is often used to adjust incomes, wages or other payments to maintain previous purchasing power in the face of changing consumer prices. In some cases, periodic changes to specific payments are made using a built-in adjustment factor, in which the CPI rate of change is applied either wholly or in part. This is currently the case, for example, for government payments resulting from such social programs as the Old Age Security and the Guaranteed Income Supplement. Some labour-management contracts also contain cost-of-living adjustment clauses, by which wages and salaries are tied to the CPI in a variety of ways. Even more frequently, the CPI serves as a point of reference in wage and salary negotiations without being applied as a built-in adjustment factor. Many other financial arrangements make reference to the CPI in adjusting the terms of payment.[13] Finally, it is likely that many Canadians monitor the CPI to judge how their incomes (or expenditures) are keeping pace with consumer price change.

13. A partial list includes: rental agreements, insurance coverage, private loans, spousal maintenance, child support allowances and CPI-indexed bonds.

2.23 As an adjustment factor, whether it is used automatically or as a point of reference, the CPI has come to affect most Canadians, and it plays an extremely important role in the economic and social affairs of the country. The CPI, for example, is a good indicator of changes in the purchasing power of the consumer dollar. However, the index does not dictate what the specific adjustments should be to wages and other forms of income. It is up to the contracting parties to determine the proportion of changes in purchasing power that should be compensated for. The following should be considered by those who use the CPI as an income adjustment factor.

2.23.1 The CPI is an indicator that relates, by definition, to a specified target population, and therefore may not reflect the experience of a particular group within this population. However, it is unlikely that the differences between the average change in consumer price indices for the target population and those for any other broad segment of the Canadian population would be large over the long run.[14]

2.23.2 The CPI, by construction, is not a Cost-of-living-Index (COLI) and while it may serve as a close approximation for one, it does not take into account some aspects or concepts which would typically be included in a COLI.[15] For example, it does not include the effect of changes in the external environment, such as the incidence of disease and natural disaster or crime levels, which may affect the demand for certain goods and services with little or no effect on prices. Additionally, as an asymmetrically weighte, fixed-basket index the CPI does not, in a timely manner, account for consumer substitutions among purchased products.[16]

2.24 The CPI is often used as a general indicator of inflation in Canada. An analysis of the CPI, in conjunction with analyses of other statistical series, can reveal fundamental trends in the economy. The CPI therefore plays an important role in the formulation of policies and in economic forecasting. The comparison of current changes in the CPI to changes in the past, and to the behaviour of similar indices in other countries, helps analysts to evaluate the effectiveness of many economic policy decisions. Although the CPI is often used as a general indicator of inflation, it is worth underlining some important limitations in this respect.

2.24.1 The CPI is not a comprehensive measure of price change at the final stage of economic transactions. This is because the index does not take into account some elements of the final use of goods and services in the country, such as the consumption of government services, capital formation or exports.

2.24.2 The mortgage interest cost index in the owned accommodation component of the CPI reflects not only current price changes, but also past changes by means of a moving weighted average of price changes over multi-year periods.[17]

2.25 The Implicit Price Index or the chain Fisher price index for domestic final expenditures in the Canadian System of National Accounts (CSNA), being free of the above limitations in addition to being calculated with a symmetrically weighted index formula, is a more comprehensive indicator of overall inflation. It is, however, released quarterly, two months after a given quarter, relates to non-market as well as market segments of the economy and relies on imputed prices for some important components, notably owner-occupied housing. It is also subject to revisions over several years as more statistical information becomes available.[18]

2.26 The importance of the CPI as a general indicator of inflation has become more apparent since February 1991, when the Bank of Canada switched to an inflation targeting regime with the all-items CPI as its target indicator. While the CPI has always been a key statistical measure used by the Bank of Canada in determining its monetary policy, the adoption of an inflation targeting regime increased the attention given to the CPI as a general indicator of inflation. Again, to help it achieve this target, the Bank of Canada defined a set of preferred measures of core inflation that are calculated and published by Statistics Canada. The purpose of these measures is to reflect persistent price movements by eliminating transitory or sector-specific fluctuations in some components of the CPI.

14. Taktek (1998), Chiru (2005).
15. For more information on the concepts of a Cost-of-living-index (COLI), see National Research Council (2002)
16. Substitution bias in the CPI is discussed in paragraph 9.22.
17. Further explanation of the mortgage interest cost index can be found in paragraphs 10.16-10.24.
18. For further information on the chain Fisher price index used in the CSNA, see Statistics Canada (2008).

Chapter 3 – Scope of the Index

3.1 The scope of the Consumer Price Index (CPI) is defined to indicate what the CPI is intended to measure. Since there are many uses of the CPI, its scope has been defined to suit as many purposes as possible. However, the diverse uses of the CPI mean that it may not suit any one purpose perfectly and therefore awareness about the scope is necessary when using the CPI for a particular function.

3.2 The CPI indicates the average price change of a fixed basket of consumer products purchased by Canadian private households. Therefore, the scope consists of transactions, for the purpose of consumption, between households in Canada and establishments operating in Canada. Only those transactions for purposes of consumption are included in the CPI. Therefore, investment expenditures, that is, transactions made with the intention of acquiring some sort of future purchasing power for example, the purchase of stocks or bonds, are excluded from the CPI. The inclusion or exclusion of particular transactions will be discussed in more detail later in this chapter.

3.3 The scope of the CPI can be mapped to several dimensions, namely: *Population coverage*, *geographical coverage*, *product coverage*, *prices* and *time*. The scope is reflected in the product and geographical classifications for which basket weights, derived primarily from the Survey of Household Spending (SHS)[19] or from national and provincial Household Final Consumption Expenditure (HFCE) series, are assigned. The intention and ideal scenario is that each good or service in scope for the CPI be represented by observed transaction prices. However, operational constraints as well as the complexity of measuring the vast and continuously changing universe of consumer transactions make this impossible to achieve in practice. As for most statistical programs, the CPI uses a sample of collected prices, which are supplemented by prices collected through administrative orand online sources.

3.4 Defining the scope of the CPI is both a conceptual and a practical exercise. The fundamental question regarding scope is: Does measuring the price change for a particular good or service fit the uses of the CPI? While there are many products for which prices could be collected, they may not necessarily suit the purposes of the index and therefore could be excluded from the scope. There are also some products which may be determined to be in scope for the CPI but for which it is too difficult to estimate consumer expenditures and/or price change. For these goods or services it is generally better to define them as out of scope than to include them without adequate measurement options.[20] The following sections of this chapter will discuss the conceptual and practical questions surrounding the scope of the CPI.

Population Coverage

3.5 The CPI target population is the group of people whose consumption expenditures are in the scope of the index. For the CPI, the target population consists of families and individuals living in urban and rural private households in Canada.[21]

3.6 The definition of private households in the CPI is consistent with that used in the Canadian Census of Population.[22] Consumption expenditures made by people living in institutions or collective households (e.g. prisons or long-term health-care facilities), as well as members of the Canadian Forces living in military camps, are excluded from the CPI scope. Expenditures made by people living on First Nations reserves are also excluded from the CPI. The decision to exclude these expenditures is primarily based on the operational difficulty of collecting data applicable to these households.

3.7 The aim of the CPI is to measure domestic consumer price change, meaning that only transactions between the target population (private households in Canada) and establishments (businesses or governments) operating in Canada are in scope. Therefore, transactions made outside of the country (e.g., restaurant meals bought while on vacation in Brazil) or transactions made with online establishments that do not physically operate within the borders of Canada are not in scope for the CPI. However, online establishments that do have physical operations in the country (e.g. a shipping warehouse) are included in the CPI.

19. For information see the Statistics Canada Survey 3508.
20. Examples include gambling and life insurance.
21. All physical boundaries of Canada are not in scope for the CPI. See sections 3.11-3.12 for more information on geographical coverage.
22. Statistics Canada, *Families Reference Guide, 2011 Census*, Catalogue No. 98-321-XWE201105.

3.8 In practice, until the 2020 basket update, the CPI did not strictly follow a 'domestic' approach because the weights used to compile the CPI basket, which were derived primarily from the SHS, followed the 'national' concept. This means they may have included household expenditures made outside of the country. Additionally, the SHS does not include spending by foreigners while visiting Canada. While these expenditures are included in final domestic demand, it was not desirable to include them in the CPI given that the index's primary uses include determining domestic monetary policy and adjusting payments of wages of Canadian residents and businesses.

3.9 Having basket weights that follow a 'national' approach has a minimal impact on the CPI given that the proportion of consumer expenditures made outside of Canada relative to the expenditures made in the country is small. If data were available on the proportion of the consumer expenditures, by product, that were made out of the country, Statistics Canada could make efforts to remove this spending from the CPI basket. Alternatively, if the expenditure data were available efforts could be made to estimate the price change for the out-of-country transactions. However, the lack of data and the operational challenges in trying to estimate out-of-country price change make these options impractical. Moreover, including price change of out-of-country transactions is not suitable for the use of the index in guiding Canadian monetary policy.

3.10 Beginning with the 2021 basket update based on 2020 expenditure data, the SHS no longer represents the primary data source for the expenditure weights used in the CPI. It has been replaced withby national level and provincial level HFCE series, which provide consumption expenditure estimates that reflect more of a domestic concept.

Geographical Coverage

3.11 The CPI covers price change experienced by private households in the ten provinces as well as Yellowknife, Whitehorse and Iqaluit. Price changes in all other areas of Yukon, the Northwest Territories and Nunavut are excluded from the scope of the CPI. While it would be desirable to include transactions made by private households in all areas within each Territory, from an operational perspective it is not practical to collect prices outside of Yellowknife, Whitehorse and Iqaluit. The decision to exclude areas outside of the main urban centres in Yukon, the Northwest Territories and Nunavut is based on the assumption that price change in the cities does not acceptably reflect price change in the remaining regions of the Territories. Therefore, the decision was made to limit the scope of the CPI in the Territories to the three northern capital cities.

3.12 All areas within the ten provinces and the three northern capital cities are in scope for the CPI, meaning that movements in the indices represent price changes for the entire province or city specified. However, because of operational constraints having to do with price collection by price collection agents, generally prices are only collected in more heavily populated areas within each province. The rationale for only collecting prices in more populated areas is based on the fact that total consumer expenditures are greater in areas with more residents, so the basket weights for the less populated areas would be quite small. Additionally, there is an assumption that price changes in less populated areas generally follow similar trends to price changes in populated areas. In this context it is important to keep in mind that the CPI aims to measure price change not price levels.

Product Coverage

3.13 The CPI measures price change for consumer products, which are goods and services that are purchased for the purpose of consumption. For the most part, products included in the CPI must be associated with a transaction price, that is, with an amount of money that a consumer must pay to purchase a specific quantity and quality of a good or service.[23]

23. Some areas of consumption, notably those within owned accommodation, do not have specific transaction prices associated with them and therefore must be imputed. These are included in the CPI despite the absence of specific transactions because they represent a significant proportion of consumer spending. The treatment of owned accommodation in the CPI is discussed in more detail in Chapter 10.

3.14 Strictly speaking, long-lived assets are excluded from the CPI. This is because they are not purchased primarily for consumption in the near future. However, distinguishing between expenditures on products for consumption and expenditures on assets for investment purposes can be quite complex for many consumer product categories, the most challenging of which is housing. Housing is seen as an asset, a durable good which provides positive economic value over an extended period of time, so house prices are not directly included in the CPI. However, a house is also consumed gradually over time by the person living in it. This is why house prices enter indirectly into the measurement of the CPI component for owned accommodation. Separating the asset portion of the house from the consumption part of the house is neither simple in concept nor in practice and this is why the treatment of owned accommodation is one of the most debatable issues surrounding the construction of CPIs around the world.[24]

3.15 In addition to housing, there are various other product categories in which it is difficult to distinguish between consumption and investment. For this reason, a selective approach is employed in the CPI. For instance, in the category of insurance, premiums for homeowners' and tenants' property insurance as well as vehicle insurance are included in the CPI scope because their premiums are related to specific goods and services (the contract normally guarantees the replacement or restoration of specified goods). In contrast, life and disability insurance are excluded because the payments stipulated in the insurance contract may be interpreted as representing future purchasing power, which cannot be associated with the consumption of any specific good or service.

3.16 While investments are excluded from the scope of the CPI, additional costs associated with making an investment transaction such as commissions or fees paid to stock brokers are included in the CPI. These fees are associated with a service provided by a financial institution and are consumed by the purchaser. Price movements for these costs are imputed from Financial Services fees which include prices for checking account fees and tax return rates (both accountant and online submissions).

3.17 Transfers are transactions where no specific goods or services are received in exchange for payments made. Income taxes are an example. Because transfers are not associated with the acquisition or consumption of specific products they are out of scope for the CPI.[25] Most goods and services financed through the public taxation system (e.g. public education, public health care) are considered transfers even though they are paid for through taxation, because a private household does not receive any specific good or service in exchange for the amount of taxes paid. Most public services are therefore excluded from the CPI.

3.18 However, not all goods or services that are publicly provided are transfers. For instance, some public goods and services have a direct user fee or cost of consumption associated with them, such as a passport, public transit, or health care charges for private hospital rooms or ambulance fees, and these are included in the CPI. Additionally, transactions made between private households and government-owned utilities or corporations, such as municipal water rates or postal services, are included in the CPI. While property taxes are classified as a transfer for many purposes, they are considered an integral part of the cost of owning and using a dwelling and thus are included in the calculation of the owned accommodation component of the CPI.[26] Other forms of transfers, including gifts, donations to charities, tips and gratuities are excluded from the CPI.[27]

3.19 From a conceptual standpoint, second hand or used goods are in scope for the CPI as long as there is a transaction between a private household and an establishment operating in Canada. However, in practice the prices for these products are usually not collected as part of the CPI sample because the associated consumption expenditures generally account for a relatively small proportion of overall consumer spending. Used car prices, introduced in the May 2022 CPI during the 2022 CPI basket update, represent an exception. A net expenditure approach is used for the estimation of household spending on used cars and price data are collected from an administrative data source.

24. The treatment of owned accommodation in the CPI is discussed in more detail in Chapter 10.
25. International Labour Office (ILO) *et al.* (2004), paragraph 3.41.
26. The treatment of owned accommodation in the CPI is discussed in more detail in Chapter 10.
27. ILO *et al.* (2004), paragraphs 3.45-3.46.

3.20 Interest that may be levied due to purchases made on credit, such as credit card or bank loan interest charges, is not included in the CPI. The issue of interest charges is very complex, raising both conceptual and practical challenges for which there is no consensus and no clear recommendation.[28] The CPI does include interest paid on a mortgage, as it is deemed an integral part of consuming an owner-occupied dwelling.[29]

3.21 Some but not all transactions involving the purchase of illegal or socially undesirable goods and services are in scope for a CPI.[30] The CPI takes a selective approach when deciding whether to include them or not. For example, tobacco products are included while illegal narcotics are deemed to be out of scope. Practical considerations in effectively measuring the prices involved in some of these transactions are a key factor.

Prices used in the Consumer Price Index

3.22 The prices included in the CPI are final prices, inclusive of all excise and other taxes paid by consumers. In particular, they include the Goods and Services Tax (GST), provincial retail sales taxes or Harmonized Sales Taxes (HST), as well as any environmental, liquor and tobacco taxes wherever applicable. It follows that the CPI could change as a result of changes in any of these types of taxes. In contrast, the CPI does not include changes in personal income taxes because as discussed above, these are transfers and are thus out of scope for the CPI.

3.23 Since the CPI includes only those transactions between private households in Canada and establishments operating in Canada, no foreign prices are included in the CPI. The prices of imported goods nevertheless have an important impact on the CPI because many of the products sold by resident establishments are either imported or have significant import content. As a result, changes in the exchange rate of the Canadian dollar against other currencies do have an impact on the CPI since they affect prices for imported goods which are then sold to domestic consumers.

3.24 Discounted prices are included in the CPI as long as they relate specifically to the product in question. That means the sale price cannot be tied to the purchase of another product (e.g. a consumer obtains a discount on a printer with the purchase of a computer). When discounts are offered in kind (e.g. free winter tires with the purchase of a new car) the purchase price is reduced by the monetary value of the product offered in kind.

3.25 The aim of the CPI is to measure the changes in prices paid by consumers and those prices sometimes differ from the associated sticker or list prices. Wherever possible, the CPI relies on scanner data (i.e. transactions recorded at the cash registry) received from retailers by Statistics Canada as a source of price data. In the absence of scanner data, the CPI relies on price collection agents, administrative data sources or automated Internet collection to proxy the prices paid by consumers.

3.25.1 With scanner data, Statistics Canada can calculate an average unit price paid by consumers for a specific product in a specific outlet during a given week. The average unit price paid is defined as the total value of sales divided by the total volume of sales. This average unit price is calculated at the product level (defined for example by the bar code) in a given outlet for a given week. Due to operational constraints, the average unit price in a given month is calculated using data from the first two full weeks of that month.

3.25.2 When scanner data is not available, Statistics Canada collects product offers (PO) as proxies for transaction prices. A PO is the presentation of a particular good or service, with an associated price, by a retailer to a purchaser. The POs used in the calculation of the CPI are determined by the CPI outlet and product samples.

28. ILO *et al.* (2004), paragraphs 3.67-3.71.
29. The treatment of owned accommodation in the CPI is discussed in more detail in Chapter 10.
30. ILO *et al.* (2004), paragraphs 3.123-3.124.

3.26 Currently, the scanner data covers products sold in a typical supermarket: food, household and personal care items. In terms of outlet coverage, Statistics Canada continues negotiating the acquisition of more scanner data from more retailers.

Time Represented in the Consumer Price Index

3.27 The smallest unit of time represented in the CPI is one month. That is, the CPI represents price change from one month to another. While in practice, prices are observed at specific moments in time within a particular month, the published indices do not represent price change occurring at any time interval less than one month. Rather, the index measures the change in average prices in one month compared to average prices in another month.

3.28 There are three approaches which can guide decisions about when to collect and incorporate a given set of observed prices in the CPI. These approaches relate to the period in time when goods and services are paid for, acquired (that is, legally owned) or consumed (that is, used). The three need not coincide and would produce different CPIs. The 'payments approach' is taken when the prices relate to the period in which the expenditures for the product are made. The "acquisitions approach" involves observing prices at the time at which the good or service is obtained by the consumer (that is, when the legal ownership of the product passes to the consumer). The 'use approach' entails observing prices at the time when a product is consumed. These times of payment, acquisition and use might extend over more than one month. For many goods and services the difference between these three approaches is not significant, because the times when consumers pay, acquire and use goods and services are typically synchronized. However, for some products, particularly durable goods or large expenditure items, the timing of price observation can yield different results.

3.29 For the majority of products, the CPI aims to follow the acquisitions approach, meaning that the observed prices relate to the transaction cost in the time period in which the legal ownership of the good passes to the consumer. The main reason for following the acquisitions approach is that it is consistent with an accrual accounting system[31] which is used in the Income and Expenditure Accounts in the Canadian System of National Accounts (CSNA).

3.30 There are also practical reasons for choosing the acquisitions approach. One, the data and information that would be required to measure the flow of service arising from the gradual consumption of various products generally makes the use approach an impractical one. Similarly, because many goods and services are purchased on credit, with multiple purchases frequently being amassed on one form of loan (e.g. a credit card whose balance is carried for many months), the consistent application of the payments approach across the CPI is not practical. Therefore, given the benefit of consistency with the accounting principles of the CSNA and Statistics Canada's practice of capturing price information from retailers' posted prices, the acquisitions approach is the most suitable choice for the CPI.

3.31 There are special cases, either for conceptual or practical reasons, that the CPI may not strictly follow the acquisitions approach. A few examples include air fares, travel tours and traveller accommodation. While the observed prices relate to the period in which the consumer obtained ownership of the ticket, travel package or hotel reservation, the prices are applied to the index in the period in which the service is used. For example, if a consumer purchases a travel package in January for a holiday in March, the price is recorded in January (the time when the consumer obtained ownership of the service); however it will not enter the CPI calculation until March (the time when the service is used). In these cases, it is practical to apply a use approach because the exact period when the service is consumed is known with certainty.

31. An accrual accounting system reflects revenue and expenses in the period in which they are deemed to have been earned and incurred, whether or not they relate to cash receipts and disbursements in the same period. See Statistics Canada (2008).

Chapter 4 – Classifications

4.1 The product and geographical classifications for the Consumer Price Index (CPI) are designed to meet three important criteria: 1) the classification reflects economic reality faced by consumers; 2) the classification meets the needs of index users, and 3) the classification is unambiguously mutually exclusive and exhaustive.[32]

4.2 The product classification is a hierarchy of over 500 elementary product classes up to the all-items CPI. There are several intermediate aggregation stages that are relevant for different levels of analysis, including the eight major aggregates (Food; Shelter; Household operations and furnishings; Clothing and footwear; Transportation; Health and personal care; Recreation, education and reading; and Alcoholic beverages, tobacco products and recreational cannabis).

4.3 The geographical classification is a hierarchy of 19 geographical strata which aggregate to Canada. Most provinces and the three northern capital cities are represented by one stratum each. However, Quebec, Ontario and British Columbia are divided into three, four and two strata respectively. The allocation of strata within these provinces is based on economic regions (ER) defined by the Canadian Census of Population.[33] While indices are computed for each geographical stratum, indices are only published for Canada, the provinces, Yellowknife, Whitehorse and Iqaluit.

4.4 The intersections of the product and geographical classifications constitute the elementary aggregates of the CPI. Elementary aggregates are the lowest-level classes to which a set of fixed-quantity basket weights is assigned. For this reason, indices for elementary aggregates are the primary building blocks to construct all indices at higher aggregation levels. Additionally, they constitute the smallest elements by which it is possible to analyze and explain price movements at aggregate levels. Finally, elementary aggregates also serve as strata for price sampling with the purpose of enhancing the reliability and relevance of the indices that are derived from samples of collected prices.

4.5 Beyond these basic rules, the designation of elementary aggregates is a matter of compromises and balances between different, often contradictory, requirements. For example, creating many very detailed elementary aggregates could be advantageous as a guide for sampling. Narrowly defined groupings of goods and services and geographies are more likely to be homogeneous from the viewpoint of price changes, which would in turn enhance sampling efficiency. On the other hand, when elementary aggregates are looked at as building blocks of the CPI it becomes essential that the indices exhibit reasonable statistical reliability. This would be difficult to achieve for numerous detailed product and geography groupings without very large price samples.

4.6 With all of this in mind, in addition to the requirement of supporting the analysis of consumer price change by various users, effort is made to designate elementary aggregates as groupings of products and geographies that:

4.6.1 Have clear and economically meaningful content.

4.6.2 Make possible the production of consumer price indices of acceptable statistical quality, given the available resources.

4.6.3 Have a reasonable degree of homogeneity in the product and geographical dimensions.

4.7 The imperative characteristic of a classification, that it must be exhaustive (covering all goods and services and geographies within the scope of the CPI) as well as mutually exclusive (no product or geographical stratum can belong to more than one elementary aggregate), gives rise to the possibility of more than 10,000 elementary aggregates in the CPI classification. However, the number is smaller in practice due to lesser product detail in some geographical strata.

32. ILO *et al.* (2004), paragraph 3.144.
33. The CPI strata for Quebec, Ontario and British Columbia are based on economic regions (ER) from the 2006 Canadian Census of Population.

4.8 Elementary aggregates are the basis of the fixed-basket concept of the CPI. Indices for elementary aggregates (lower level) are the starting points of the CPI aggregation using the Lowe fixed-basket formula (upper level).[34]

4.9 The Canadian CPI also makes use of basic classes, a chosen point in the classification in which the quantity weights are unchanged for the duration of the basket. This means that the quantities for elementary aggregates below the basic class level may be adjusted during the lifespan of a basket as long as the quantities at the basic class level are unchanged.[35] In many cases, basic classes are equal to elementary aggregates.

4.10 In an effort to further support the analysis of consumer price changes, many special aggregates are also produced. Special aggregates such as, “goods”, “services”, or “all-items excluding food and energy” are constructed by aggregating different groups of elementary aggregate indices. These special aggregates are analytically helpful and are useful in understanding the contributions of certain elementary aggregates to overall price change.

34. The calculation of indices at the lower and upper levels is discussed in Chapter 6.
35. The CPI basket weights and the process for updating them are discussed in Chapter 8.

Chapter 5 – Sample Strategy and Price Collection

5.1 The number and variety of transactions that consumers engage in is immense. It would be neither practical nor affordable to collect prices for all transactions of products sold in all outlets[36] to compile the Consumer Price Index (CPI). Therefore a sample strategy is necessary.

5.2 The CPI has always had a policy of adopting the most appropriate measurement methodologies for each of its elementary indices. This has led to sometimes very divergent sampling practices in different parts of the CPI. This chapter will cover the range of sampling practices currently used in the CPI, first focusing on the general sampling approach which covers more than 50% of the CPI by basket weight.[37] The chapter will then discuss some of the more specific sampling approaches in other parts of the basket, including full-universe price coverage, cut-off sampling and price modelling.

5.3 Not all elementary price indices are estimated with prices observed by price collection agents.

5.3.1 For some elementary aggregates, particularly the "catch-all" classes with heterogeneous product mixes that typically represent more marginal consumer expenditures, price collection is not practical or necessary. In these cases, imputations are made whereby the price movement of the elementary aggregate is estimated via proxy, using the price movement of a donor class.

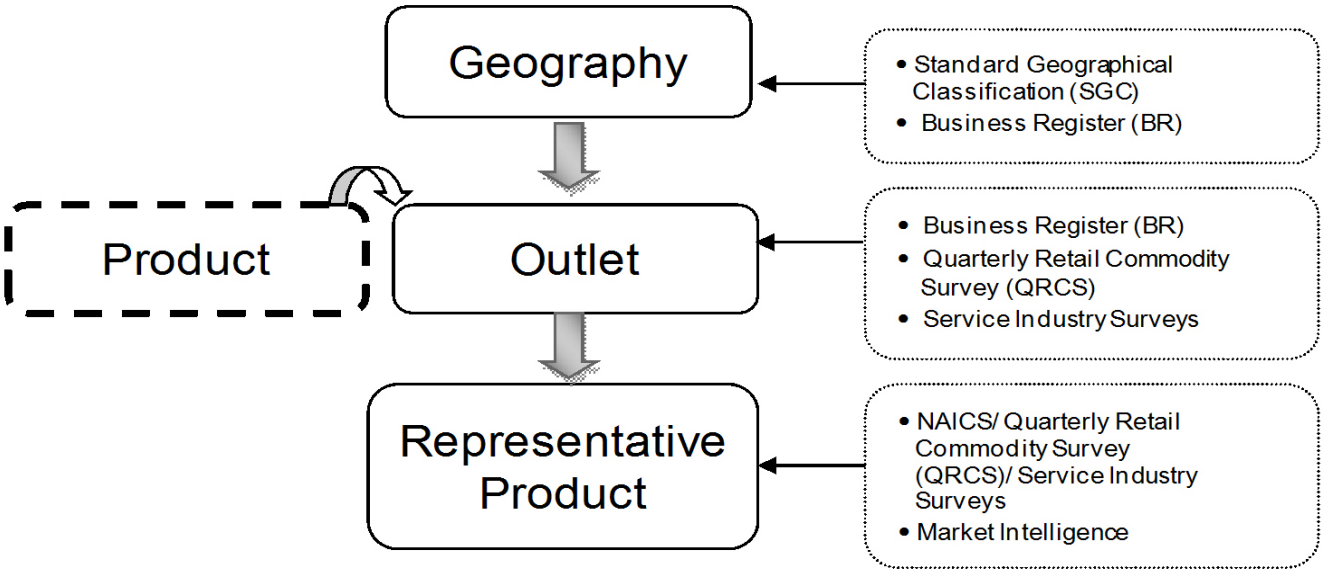
5.3.2 For some outlets, Statistics Canada receives transaction information as recorded at the cash registers of retailers. In that case, scanner data are used to calculate the transaction price of specific items. As the coverage of scanner data increases in terms of outlets and products, Statistics Canada switches away from traditional price collection by price collection agents to the use of scanner data.For some indices (passenger vehicles insurance premiums, homeowners' insurance, mortgage interest cost and gasoline), Statistics Canada uses administrative datasets to estimate the price paid by consumers. For a few clothing and footwear retailers as well as computer equipment and software retailers, prices and product features are collected through web scraping of the retailers' websites. For the air transportation index, prices are collected through the use of application programming interfaces. In other instances (rental of passenger vehicles, traveler accommodation and package holidays), Statistics Canada uses Internet-based manual collection to record the prices posted by the retailers.

General Sampling Approach

5.4 The general sampling approach for the CPI can be seen as a three-stage survey design. The first stage covers geography, the second is for outlets and the third stage is for the products. Even though the product component appears at the last stage, types of products have a major influence during the second stage when outlets are selected. Figure 5.1 depicts this general approach for selecting sampling unit, starting from geography, then using the product type information for outlet selection and then assigning representative products (RP) to be observed within each outlet. More details on each of these stages are provided in the following paragraphs.

36. The term "outlet" refers not just to stores in the normal sense of that word, but also Internet sellers, vending machines, door-to-door vendors, catalogue mail order merchants, telephone salespeople and vendors using other means to connect with customers.
37. This proportion of the products in the CPI which are covered by the general sampling strategy is estimated using the 2017 basket weights. Statistics Canada, survey 2301.

Figure 5.1
Stages of Sampling Strategy in the Consumer Price Index



5.5 The geographical sampling unit is primarily the Census Sub-Division (CSD) as defined by Statistics Canada's Standard Geographical Classification (SGC). CSDs are similar to municipalities and are chosen for the CPI sample based on information such as population counts and economic activity.[38] The CSDs are selected as the sampling unit mainly because they are stable over time and because every location in the Business Register (BR),[39] the frame for outlet selection, is mapped to CSDs.

5.6 To facilitate outlet sampling and price collection management, CPI collection areas have been defined. For small to medium size CSDs, collection areas correspond to the CSD. In cases where the CSD is too large to represent one collection area it is broken down into smaller areas which are amalgamations of Census Tracts (CTs), which can be seen as equivalent to neighbourhoods. The number of collection areas within a CSD depends on the number and variety of retail and services locations as well as the size, in terms of square kilometres, of the CSD.[40]

5.7 The CPI survey frame is used to select the outlets where prices will be observed by price collection agents. The frame was built using existing Statistics Canada sources, mainly the BR, the quarterly Retail Commodity Survey (RCS)[41] and services industry surveys such as the monthly Food Services and Drinking Places Survey. The RCS and services industry surveys are used to link the CPI product classification to the industry classification in the BR, which is the North American Industrial Classification System (NAICS).

5.8 A major feature of the CPI survey frame is that it gives the revenue, according to the BR, of each outlet by RCS commodity class or service industry using the data reported in various Statistics Canada surveys. This characteristic of the frame helps in dealing with big retailers such as the department stores, which typically sell a range of products. It facilitates the selection of outlets which are among the most popular in each product class or service industry.

38. Beaulieu (2012).
39. The Business Register is a listing of all business units that operate in Canada. It is compiled by Statistics Canada for use in conducting business surveys.
40. More details are available in Beaulieu (2012).
41. Beaulieu (2012).

5.9 The outlet sampling process for the CPI is done in two phases. The first phase, pre-contact sampling, is designed to validate the information from the BR, such as activity status, industrial classification and contact information. Depending on the industrial classification, additional questions may be asked to determine whether specific products are sold. The second phase consists of selecting a subset of outlets from the pre-contact output (after all out-of-scope and refusal units are removed). Remaining in-scope outlets that were not selected for the sample are kept as a replacement list.

5.9.1 If the outlet selected is not one of the outlets for which Statistics Canada receives scanner data, the information is sent for price collection by specialized Statistics Canada employees, known as price collection agents.

5.9.2 If Statistics Canada has scanner data (transaction data) from the outlet selected, no price collection by price collection agents is needed. Instead, an employee from Statistics Canada head office will use the transaction data to calculate average unit prices.

5.10 After outlets are selected, a set of RPs is assigned to be observed in each outlet. Subject matter experts use external databases and market research to help define RPs in a way that strikes a balance between specificity and flexibility. Price collection agents or employees working with scanner data then select specific products that meet the RP definitions. This approach ensures a clear understanding about what kind of product to select (keeping intact the matched-model approach of the CPI) while at the same time providing leeway to choose products that are locally popular (upholding the representativeness of the estimated elementary indices).

5.11 The RP list may be different from one outlet to another according to the information obtained from the CPI survey frame and the pre-contact phase. For example, one pharmacy may be designated to have health care goods as well as some food items (such as milk and bread) collected if those products correspond to its main streams of revenue. However, this may not be the case for all pharmacies in the CPI sample.

5.12 The number of RPs assigned to each elementary aggregate depends on the weight and the complexity of measuring price change for the given product class. In a complex elementary aggregate, one which may have a lot of heterogeneous products included, several RPs will likely be assigned. In a simpler elementary aggregate, just one or two RPs might be enough to measure price change adequately.

5.13 An RP assigned to an outlet is called a target product offer (TPO). The TPO acts as the sample intention. The sampling allocation scheme allots a number of TPOs to each elementary aggregate, taking into account the basket weight, price variability and cost of collection for each elementary aggregate. The objective is to allocate the available sample optimally in order to estimate elementary indices of the best possible quality.[42]

5.14 Every month the price collection agents observe product offers (PO) for TPOs. The monthly process begins with a detailed sample request from headquarters to the price collection agents. Most of this request is the same as in the previous month, since the CPI follows the matched-model approach. The sample request is loaded into Computer-Assisted Personal Interview (CAPI) devices. Carrying these devices, the price collection agents consult the local website or flyer of each of the outlets in their particular workload, they can also call the stores. In each outlet, the interviewer finds the required POs and enters their prices and characteristics into the devices. Instead of in-person visits, the price collection agents can also make a telephone call or use retailers' local flyers or websites for price collection, as it has been since the onset of the COVID-19 pandemic

5.15 When a PO is advertised as being "on special" price collection agents record this in the CAPI device. If the item cannot be found because it is marked out of stock, the interviewer may search for a close replacement item. Details on the replacement item are recorded in the device and transmitted back to Statistics Canada headquarters.

42. Beaulieu (2012).

5.16 If the PO being sought is determined to be no longer carried, a substitute PO is selected and this information is recorded in the CAPI device. For especially complex POs such as high-tech goods, sporting and live performance goods and items of clothing, the price collection agents also fill out forms providing additional details about the characteristics of the substitute PO. This additional information assists the analysts at headquarters who assess the extent of quality change and estimate an appropriate adjustment.[43]

5.17 When an interviewer must select a substitute PO, as just described, he or she is guided by the RP description, a set of detailed product specifications loaded in the CAPI devices. The interviewer is asked to select a substitute PO that fits the description.

5.18 For many RPs it is not necessary to observe POs every month, either because their prices tend to change less frequently or because they are only available at specific times of the year. For one example, tuition fees typically change only once a year, in a predictable month, so they are collected only in that month. For another, property tax data is collected once a year from municipal offices because property taxes are charged to homeowners annually. In fact, every RP description specifies the month(s) of price obervation.

5.19 If a price change is known to take place outside an RP's default pricing schedule Statistics Canada will conduct a special pricing.[44] This ensures that elementary indices represent, as much as possible, price change in a timely manner.

5.20 As for the timing of price observation within the month, most POs are observed in the first two weeks, with the first week being defined as the one containing at least three business days from the calendar month. Gasoline prices are an exception due to their typical intra-month volatility and thus are collected in four weeks.

5.21 When the POs have been collected they are sent to Statistics Canada headquarters by encrypted digital transmission, where they are compared against the original sample request to determine the sample's completeness and conformity to requirements. Thereafter, the POs undergo further review and processing. Any unusual price movements are carefully checked to ascertain their validity. Corrections are made if necessary. Where POs have been substituted, the degree of quality difference is assessed and an appropriate quality adjustment is made if necessary. Steps are also taken to ensure the POs include applicable taxes. Finally, with all checks and adjustments completed, the elementary price indices are calculated.

Specific Sampling Approaches

5.22 Exceptions are made to the general sampling approach. These exceptions are intended to capture price change for elementary aggregates where information on the universe of consumer transactions is available or where the attributes of the products within the elementary aggregate are complex and require different techniques.

5.23 Elementary aggregates where full information on the universe of consumer transactions is available include those goods or services that have only one market and/or seller. Examples include passport fees and drivers' licences. For these there is no sample drawn because all prices are collected and used in the CPI.

5.24 For some elementary aggregates in which there is one seller in a particular geographical stratum,[45] a sample of outlets and products is not required. However, in these cases the first stage of the general sampling approach, in which collection areas are selected, is still necessary. Usually, the collection of theses POs is done by employees at Statistics Canada headquarters rather than by price collection agents in different regions.

5.25 The prices used to calculate the rent price index come from the Labour Force Survey, which uses a probabilistic sample.[46]

43. Quality adjustment techniques used in the CPI are discussed in Chapter 7.
44. Examples where special pricing occurs include tax changes or other advertised/scheduled price changes, such as increases to government regulated service fees.
45. Examples of product classes where there is one seller in a particular geographical stratum include some public utilities such as water or electricity companies.
46. Statistics Canada, Survey 3701.

5.26 Some elementary aggregates in the CPI follow cut-off sampling.[47] When there is information available on the outlet and/or product universe the goal is to maximize the coverage of both. Most times information on market composition comes from third party administrative databases, often available via the Internet. These databases are used to rank outlets and/or products so the sample covers a majority of the market. Once TPOs are assigned via cut-off sampling, POs are collected at Statistics Canada headquarters. For some retailers, when specific relevant sale information is available, other product sampling strategies may be used.

5.27 There are some elementary aggregates where the target population purchases bundles of services rather than individual products[48] or where prices are based on a set of specific conditions.[49] The CPI uses the profiles method to capture price change for these products.

5.28 Representative bundles or consumer profiles are selected using available market information. The intention is to cover a majority of the services and outlets that are available in a particular market. In these cases POs for the defined consumer profiles are observed at Statistics Canada headquarters from large industry databases.

5.29 The profiles method is another application of the matched-model framework. By observing POs of identical consumer profiles every month, this method ensures that the quantity and quality of bundled services are constant over time and that the CPI reflects pure price change. As with the entire CPI sample, it is important that consumer profiles are reviewed and updated regularly to ensure that representative consumption bundles are being priced. When profiles must be changed because the component products are determined to be new or of different quality, then quality adjustment techniques are applied.

5.30 Some elementary aggregates are characterized by products whose prices are determined not by their physical characteristics, but by their intellectual content and novelty. For these elementary aggregates the CPI uses the bestsellers method to estimate price change.[50] In these cases, POs are observed by price collection agents who refer to local outlets or to the websites of online retailers.

5.31 There are three elementary aggregates which use modelling to estimate price change: the Mortgage interest cost and the Homeowners' replacement cost indices (two components of the owner-occupied accommodation price index), and the rent index (the largest component of the rented accommodation price index). Unlike the treatment of other durable goods in the CPI, owner-occupied housing follows a user-cost approach, which aims to measure the implicit price of the flow of services coming from a fixed stock of owned dwellings. The two components of this price index require special measurement methods.[51] The rent index estimation is based on data collected from the Labour Force Survey and a hedonic regression model.[52]

47. Examples of elementary aggregates that use cut-off sampling are the purchase of passenger vehicles and various telecommunication indices such as telephone services, Internet access services and cablevision and satellite services.
48. Examples of elementary aggregates that follow the profiles method are products that are typically purchased in package form, such as banking fees, cable and satellite television fees.
49. The best example of such a product is insurance, as home or car insurance premiums are based on the characteristics of the home or driver being insured as well as the desired coverage characteristics.
50. An example of an elementary aggregate that uses the bestsellers method is Books and other reading material (excluding textbooks). The price index is based on the estimated total cost of the top 10 bestsellers in sampled bookstores in each period.
51. The treatment of owner-occupied accommodation in the CPI along with the specific model calculations for the Mortgage interest cost and Homeowner's replacement cost indices are discussed in Chapter 10.
52. The rent index methodology is discussed in paragraphs 7.22-7.24.

Chapter 6 – Calculation of the Consumer Price Index

6.1 The Consumer Price Index (CPI) is calculated in two stages, termed the lower level and the upper level.

6.2 At the lower level of calculation, price change is estimated for elementary aggregates. These are found at the lowest level in the product and geographical classifications of the CPI and are most often calculated using a Jevons (geometric mean) index number formula. Elementary aggregates consist of similar groups of products in a geographical stratum.[53]

6.3 At the upper level, an asymmetrically-weighted fixed-basket Lowe price index formula (Laspeyres-type) is used to combine elementary aggregates in order to obtain upper level aggregate indices.

6.4 This chapter will discuss the two-stage calculation of the CPI, first explaining the computation of elementary indices at the lower level. While the chapter will focus on the standard method for computing indices, some non-standard methods used in the CPI will also be discussed. Then the chapter will explain the method used to aggregate elementary price indices to the upper level.

Calculation of Elementary Indices (lower level)

6.5 At the lower level, elementary price indices are calculated for over 500 elementary product classes in each of the 19 geographical strata of the CPI.[54] Elementary indices can be understood as the building blocks of the CPI and represent the lowest level of the fixed-basket index hierarchy. Estimation of price change at this level is usually done via the standard approach for elementary price index calculation. Exceptions are made for special cases addressed later in this chapter.[55]

6.6 Not all elementary indices are derived directly from observed prices. About 75% of elementary indices, by basket weight, are derived directly from observed prices within their product class and geography. The proportion of elementary indices estimated with direct price observation varies across geography. The remaining portion of elementary indices is imputed, either from another closely related product class, or from the same product class in another geographic stratum. [56]

6.7 Most of the elementary aggregates that are not calculated using observed prices are catch-all product classes; as such, they represent more marginal and diverse varieties of products which do not fit neatly into any of the other elementary product classes. Typically these catch-all product classes would also be significantly more expensive to estimate via direct price observation. Their price change is usually estimated by imputing the price movement from another elementary price index for which prices are observed.

6.8 While it would appear ideal that all elementary price indices be calculated using observed prices within their product class, this is not always necessary. Since the goal of the CPI is to measure price change, and not absolute price levels, sampling strategies are developed to reflect which product offers (PO) are the most important to capture directly, and which others may be suitably estimated via imputation.[57]

6.9 The CPI follows the matched-model approach for calculating elementary price indices whereby identical (unchanging quantity and quality) POs are followed through time. However, it is not always possible to follow the same products across time, as new goods and services are constantly emerging and old ones disappearing. When an identical PO cannot be collected in a subsequent period, a replacement PO must be observed. This chapter will not discuss situations where POs are replaced.[58]

53. Classifications of the CPI are discussed in Chapter 4.
54. There are slightly fewer elementary aggregates (that is, "building blocks") to the CPI than the maximum of the product of the total number of elementary product classes and the number of geographical strata because not all of the 19 geographic strata have the full set of elementary product classes available. The absence of product classes occurs mainly in the small geographic strata. Each elementary aggregate has a corresponding expenditure weight used in the upper-level calculation.
55. Some common index formulae used to calculate elementary price indices can be found in the appendix.
56. Of these elementary aggregates estimated by proxy, roughly half, by basket weight, are product imputations (e.g. price movements for college tuition fees are imputed from the price movement of university tuition fees within each geographic stratum) and the other half are geographic imputations (e.g. price movements for baseball game admission fees in Prince Edward Island are imputed from those in Toronto).
57. The sampling strategy for the CPI is discussed in Chapter 5.
58. The ways in which adjustments are made for the quality changes that may occur when product offers (PO) are replaced are discussed in Chapter 7.

6.10 Examples where the calculation of elementary price indices is a relatively simple matter are the few elementary aggregates for which there is one product having a single price. These product classes typically have goods or services for which prices are determined by a level of government, such as drivers' licences or passport fees. In such cases, the ratio of one month's price over the previous month is the best estimate of price change. However, for the majority of elementary product classes reality is more complex, mainly because of the availability of many competing and continuously changing product types.

6.11 In the majority of cases, elementary price indices are based on a sample of prices for one or more goods or services belonging to the elementary product class. The sampled POs receive equal weighting in this elementary calculation, because consumer expenditure weighting information is usually not available at this level.

6.12 The following section describes the standard approach for calculating elementary price indices. The chapter will then go on to discuss several of the elementary price indices for which estimation methods differ from the standard approach either because of the complex nature of estimating price change for the goods and services within the elementary product class or because additional information is available that can be used to produce an improved elementary price index.

The Standard Approach for Calculating Elementary Price Indices

6.13 The standard approach refers to the most commonly used method of combining prices, in order to estimate price change for elementary aggregates in the CPI. Typically consumer expenditure patterns below the elementary aggregate level are not known and therefore the implicitly equally weighted geometric mean, known as the Jevons formula (6.1), is used to calculate an average price relative from the sample of the collected POs. This means the price relative of each collected PO is assigned equal importance in the calculation. The Jevons formula has been used by Statistics Canada since 1995 as its primary formula for the calculation of elementary price indices in the CPI.

$$I_{J,a}^{t-1:t} = \prod_{i=1}^{n} \left(\frac{p_i^t}{p_i^{t-1}} \right)^{1/n} \qquad (6.1)$$

where:

$I_{J,a}^{t-1:t}$ is the implicitly weighted Jevons price index for elementary aggregate a between period $t-1$ and period t ;

n is the number of POs i in elementary aggregate a ; and

$\frac{p_i^t}{p_i^{t-1}}$ is the price relative for PO i between period $t-1$ and period t.

6.14 The Jevons formula (6.1) can also be calculated by taking the ratio of the implicitly weighted geometric mean prices of the observed POs in the two periods being compared (6.2).

$$I_{J,a}^{t-1:t} = \frac{\prod_{i=1}^{n} (p_i^t)^{1/n}}{\prod_{i=1}^{n} (p_i^{t-1})^{1/n}} \qquad (6.2)$$

where:

$\prod_{i=1}^{n} (p_i^t)^{1/n}$ is the geometric mean price for all POs i for elementary aggregate a in period t ; and

$\prod_{i=1}^{n} (p_i^{t-1})^{1/n}$ is the geometric mean price for all POs i for elementary aggregate a in period $t-1$.

6.15 The Jevons formula was adopted because it has advantages over the previously used Dutot formula.[59] Firstly, the geometric mean of price relatives (Jevons) is less influenced by extreme prices than is the ratio of arithmetic mean prices (Dutot). The resulting elementary price indices are less volatile.[60] Secondly, elementary price indices that are calculated as geometric mean of price relatives (Jevons) can be interpreted in two ways; first, as an average of price changes (6.1) and second as a change in average prices (6.2). The first interpretation, which is only applicable to the Jevons formula, is convenient for explaining the composition of aggregate price changes.

Other Methods for Calculating Elementary Price Indices

6.16 Among the elementary product indices there are several departures from the standard approach. Exceptions to the standard approach are usually made because more complete information is available on the universe of transactions within the elementary aggregate.

6.17 Post-1995, arithmetic formulae were retained for the calculation of a few elementary price indices (Passenger vehicle insurance premiums and Tuition fees). What sets these elementary aggregates apart is that the sampled POs are drawn from a population frame and there is confidence that the sample sufficiently represents the universe of consumer expenditures for these product classes. Furthermore, the contractual nature of the expenditures in these product classes means that it is likely that product substitution will not take place over the period of price comparison. The unweighted arithmetic formula used in the Canadian CPI is the Dutot (6.3).[61]

$$I_{D,a}^{t-1:t} = \frac{\sum_{i=1}^{n} \frac{1}{n} p_i^t}{\sum_{i=1}^{n} \frac{1}{n} p_i^{t-1}} \qquad (6.3)$$

where:

$I_{D,a}^{t-1:t}$ is the Dutot price index for elementary aggregate a between period $t-1$ and period t ;

n is the number of POs i in elementary aggregate a ;

$\sum_{i=1}^{n} \frac{1}{n} p_i^t$ is the arithmetic mean price for all POs i for elementary aggregate a in period t ; and

$\sum_{i=1}^{n} \frac{1}{n} p_i^{t-1}$ is the arithmetic mean price for all POs i for elementary aggregate a in period $t-$.

6.18 An explicitly weighted geometric mean formula (6.4) is used in a few special cases where more detailed expenditure information is available below the elementary aggregate level. Examples where an explicitly weighted geometric mean formula is used are the indices for postal fees, newspapers and magazines, urban transit and parking rates.

$$I_{WJ,a}^{t-1:t} = \frac{\prod_{i=1}^{n} \left(p_i^t\right)^{w_i / \sum_{i=1}^{n} w_i}}{\prod_{i=1}^{n} \left(p_i^{t-1}\right)^{w_i / \sum_{i=1}^{n} w_i}} \qquad (6.4)$$

59. The Dutot formula was used as the standard method for calculating elementary price indices in the CPI prior to 1995.
60. The geometric mean of price relatives (Jevons) can be more volatile than the ratio of arithmetic mean prices (Dutot). This occurs in the case of very steep price drops as with liquidation sales. Liquidation sale prices, although they are part of the universe of consumer expenditures which the CPI aims to measure, are excluded from the CPI sample. This is because liquidation sales are deemed less representative of the average consumer transaction.
61. The use of the Dutot formula is appropriate when POs are expressed in a homogenous unit of measure. ILO *et al.* (2004), paragraphs 20.64-20.68. When quantity or expenditure information is available, an explicitly weighted Laspeyres-type formula (6.5) can be used, with the same weights appearing in the numerator and the denominator.

where:

$I_{WJ,a}^{t-1:t}$ is the explicitly weighted Jevons price index for elementary aggregate a between period $t-1$ and period t ; n is the number of collected POs i in elementary aggregate a ;

$\prod_{i=1}^{n}\left(p_i^t\right)^{w_i/\sum_{i=1}^{n}w_i}$ is the explicitly weighted geometric mean price for all POs i in elementary aggregate a in period t ;

$\prod_{i=1}^{n}\left(p_i^{t-1}\right)^{w_i/\sum_{i=1}^{n}w_i}$ is the explicitly weighted geometric mean price for all POs i for elementary aggregate a in period $t-1$; and

$w_i/\sum_{i=1}^{n}w_i$ is the weight of PO i as a proportion of the aggregate weight for all POs.

6.19 The weights used in the calculation of the weighted geometric mean do not have to relate to the period of price comparison, however in each comparison period they are fixed. The weights are obtained from administrative records or other data sources. These cases can be seen as improvements on the standard approach because rather than giving implicit equal importance to each price relative (6.1) they make use of additional information about the relative importance, or size, of each group of transactions.

6.20 In cases where there are different product types available within one elementary aggregate, but each product type is homogeneous, a unit value index is a preferred method for calculating elementary price indices. A unit value index is simply the quantity-weighted average transaction price for all products within an elementary aggregate in one period, divided by the quantity-weighted average transaction price in the previous period (6.5).

$$I_{U,a}^{t-1:t}=\frac{\left(\frac{\sum_{i=1}^{n}q_i^t p_i^t}{\sum_{i=1}^{n}q_i^t}\right)}{\left(\frac{\sum_{i=1}^{n}q_i^{t-1} p_i^{t-1}}{\sum_{i=1}^{n}q_i^{t-1}}\right)} \qquad (6.5)$$

where:

$\frac{\sum_{i=1}^{n}q_i^t p_i^t}{\sum_{i=1}^{n}q_i^t}$ is the quantity-weighted average price in period t using quantities from period *t*

$\frac{\sum_{i=1}^{n}q_i^{t-1} p_i^{t-1}}{\sum_{i=1}^{n}q_i^{t-1}}$ is the quantity-weighted average price in period t-1 using quantities from period *t*-1.

The rationale for using a unit value calculation must be based on a reasonable assumption that the changes in these average prices do not reflect a change in quality over time. Otherwise the index could be prone to bias.[62]

6.21 The CPI uses a unit value calculation for the spectator entertainment index, which includes prices for stadium sports seating and live staged performances. The assumption behind this index is that if the stadium or theatre is full in each of the two periods being compared, there is likely to be no change in the overall quality, even though seats may be valued differently. In effect, the price of all seats in the stadium or theatre is used rather than a few individual seats.

6.22 A unit value calculation is also used in the property taxes elementary price index. A sample of properties is drawn so that the average annual property tax paid in a given municipality can be calculated. These calculated average annual taxes are then multiplied by the total stock of dwellings in each municipality in order to obtain the average annual property tax paid in each CPI geographical stratum. No attempt is made to control for differences in the quality of services that homeowners receive in exchange for their tax payments from one municipality to another. Additionally, there is no treatment to control for changes in the quality of municipal services from one period to another. Accounting for these differences is impractical as there are no data available which associate specific municipal services to proportions of property taxes paid.[63]

Calculation of the Consumer Price Index Above Elementary Indices (upper level)

6.23 The calculation of the CPI at the upper level is relatively straightforward compared to the lower level. It involves aggregating calculated elementary price indices by applying an asymmetrically weighted arithmetic fixed-basket formula in order to obtain aggregate indices which culminate in the all-items CPI.[64]

6.24 The Laspeyres formula (6.5) is a basic method for calculating price indices and is consistent with the CPI's fixed basket concept. It expresses the change in the cost between period 0 and period t of buying a fixed basket of products, by aggregating the prices of the products in the basket using quantities consumed from the price reference period 0 as weights.

$$I_{L,A}^{0:t} = \frac{\sum_{i=1}^{n} p_i^t q_i^0}{\sum_{i=1}^{n} p_i^0 q_i^0} \qquad (6.5)$$

where:

$I_{L,A}^{0:t}$ is the Laspeyres price index of aggregate class A between period 0 and t;

n is the number of elementary aggregates i in the aggregate class A;

p_i^t is the price of elementary aggregate i, in time t;

p_i^0 is the price of elementary aggregate i, in time 0; and

q_i^0 is the quantity weight of elementary aggregate i, in the price reference period 0.

62. Balk (2002) showed that unit value ratios require special consideration, as they are not only driven by price change but can also be driven by changing quantities.
63. The treatment of owned accommodation in the CPI is discussed in Chapter 10.
64. Some common formulae for calculating aggregate price indices (above the elementary level) can be found in the appendix.

6.25 In practice, the Laspeyres index is not commonly used to calculate the CPI because it requires information on the quantities consumed[65] in the price reference period 0 and these data are not available in a timely manner. This has to do with the fact that household expenditure surveys or the Canadian System of National Accounts' (CSNA) household final consumption expenditure (HFCE) data are typically produced with a lag. Therefore, since Statistics Canada aims to produce a CPI that is timely, in that it measures changes in prices for recent periods, the Laspeyres formula must be altered to use quantities from a period preceding the price reference period 0. This transformation is the Lowe formula (6.6), a more general form of a Laspeyres index because the quantities come from a chosen weight reference period b. In the case of the CPI, b precedes the price reference period 0.

$$I_{Lo,A}^{0:t} = \frac{\sum_{i=1}^{n} p_i^t q_i^b}{\sum_{i=1}^{n} p_i^0 q_i^b} \qquad (6.6)$$

where:

$I_{Lo,A}^{0:t}$ is the Lowe price index of aggregate class A between period 0 and t;

n is the number of elementary aggregates i in the aggregate class A;

p_i^t is the price of elementary aggregate i, in time t;

p_i^0 is the price of elementary aggregate i, in time 0; and

q_i^b is the quantity weight of elementary aggregate i, in the weight reference period b, with $b \leq 0 < t$.

6.26 The Lowe index can also be expressed as the weighted sum of elementary price indices (6.7) with the weights expressed as expenditure shares.

$$I_{Lo,A}^{0:t} = \sum_{i=1}^{n} \left(\frac{p_i^t}{p_i^0} \right) s_i^{0b} \qquad (6.7)$$

where:

$\frac{p_i^t}{p_i^0}$ is the price index of elementary aggregate (i) between periods 0 and t, and;

$$s_i^{0b} \equiv \frac{p_i^0 q_i^b}{\sum_{i=1}^{n} p_i^0 q_i^b} \qquad (6.8)$$

6.27 The expenditure shares s_i^{0b} in the Lowe formula (6.7) are hybrid expenditures because the prices and quantities (that equal the expenditures when multiplied) are from different periods, 0 and b.

6.28 Hybrid expenditure shares (6.8) are obtained by updating the original expenditure weights $p_i^b q_i^b$ (observed in the weight reference period b) to reflect the prices of the price reference period 0 using the price relatives $\frac{p_i^0}{p_i^b}$. This process is often referred to as price-updating and thus hybrid expenditure weights are frequently termed price-updated weights.[66] The use of price-updated or hybrid expenditure weights is essential to the fixed-quantity basket concept of the CPI.

6.29 Because the weights used in the calculation of the CPI are obtained from consumer expenditure data with a weight reference period that precedes the price reference period 0, the Lowe index formula is the practical option for computing a timely CPI.

65. In practice, what are observed are the expenditures, which contain the implicit p and q terms.
66. ILO *et al.* (2004), paragraph 1.29.

6.30 Notwithstanding this practical advantage, the Lowe formula also has many desirable properties. One is its consistency in aggregation. This means that no matter in which order the elementary price indices are aggregated (for example first by geographical stratum and then by product class, or the reverse) the aggregate index results are the same.

6.31 Another desirable property of the Lowe formula is its transitivity,[67] whereby the ratio of two Lowe indices using the same set of basket reference quantities q^b is also a Lowe index (6.9).[68] This property is useful because it enables index compilers to calculate short-term price movements. For example, price change between period $t-1$ and period t can be estimated by taking the ratio of two long-term Lowe price indices, one comparing periods 0 and $t-1$ and the other comparing periods 0 and t.

$$I_{Lo,A}^{t-1:t} = \frac{\sum_{i=1}^{n} p_i^t q_i^b}{\sum_{i=1}^{n} p_i^{t-1} q_i^b} = \frac{\frac{\sum_{i=1}^{n} p_i^t q_i^b}{\sum_{i=1}^{n} p_i^0 q_i^b}}{\frac{\sum_{i=1}^{n} p_i^{t-1} q_i^b}{\sum_{i=1}^{n} p_i^0 q_i^b}} = \left(\frac{I_{Lo,A}^{0:t}}{I_{Lo,A}^{0:t-1}} \right) \qquad (6.9)$$

where:

$I_{Lo,A}^{t-1:t}$ is the short-term Lowe index for aggregate A between period $t-1$ and period t;

$I_{Lo,A}^{0:t}$ is the long-term Lowe index for aggregate A between period 0 and period t, and;

$I_{Lo,A}^{0:t-1}$ is the long-term Lowe index for aggregate A between period 0 and period $t-1$.

67. Transitivity is an axiomatic property of index number formulae. Satisfying this property enables price indices to be calculated via chained or direct price comparison. For more information on this property, ILO et al. (2004), paragraphs 9.25 and 15.88.
68. ILO *et al.* (2004), paragraph 1.26.

6.32 The transitivity property of the Lowe formula also enables index compilers to calculate long-term price change by chaining together short-term price indices. For example, a Lowe index comparing prices in period t to prices in the price reference period 0 is obtained by multiplying the Lowe index comparing period t to period $t-1$ by the Lowe index comparing period $t-1$ with the price reference period 0 (6.10). The product of monthly chained indices provides identical results to an index that directly compares prices in period t to prices in the price reference period 0.

$$I_{Lo,A}^{0:t} = \underbrace{\underbrace{\left[\frac{\sum_{i=1}^{n} p_i^1 q_i^b}{\sum_{i=1}^{n} p_i^0 q_i^b}\right]}_{I_{Lo,A}^{0:1}} \times \underbrace{\left[\frac{\sum_{i=1}^{n} p_i^2 q_i^b}{\sum_{i=1}^{n} p_i^1 q_i^b}\right]}_{I_{Lo,A}^{1:2}} \times \ldots \times \underbrace{\left[\frac{\sum_{i=1}^{n} p_i^{t-2} q_i^b}{\sum_{i=1}^{n} p_i^{t-3} q_i^b}\right]}_{I_{Lo,A}^{t-3:t-2}} \times \underbrace{\left[\frac{\sum_{i=1}^{n} p_i^{t-1} q_i^b}{\sum_{i=1}^{n} p_i^{t-2} q_i^b}\right]}_{I_{Lo,A}^{t-2:t-1}}}_{I_{Lo,A}^{0:t-1} = \frac{\sum_{i=1}^{n} p_i^{t-1} q_i^b}{\sum_{i=1}^{n} p_i^0 q_i^b}} \times \underbrace{\left[\frac{\sum_{i=1}^{n} p_i^t q_i^b}{\sum_{i=1}^{n} p_i^{t-1} q_i^b}\right]}_{I_{Lo,A}^{t-1:t} = \sum_{i=1}^{n} \left(\frac{p_i^t}{p_i^{t-1}}\right) s_i^{t-1b}} \qquad (6.10)$$

where:

$I_{Lo,A}^{0:t}$ is the long-term Lowe index for aggregate class A between period 0 and t;

$I_{Lo,A}^{t-1:t}$ is the monthly short-term Lowe index for aggregate A; and

s_i^{t-1b} is the hybrid expenditure share of elementary aggregate i, with quantities from the basket reference period b expressed at period $t-1$ prices, derived as (6.11).

$$s_i^{t-1b} \equiv \frac{p_i^{t-1} q_i^b}{\sum_{i=1}^{n} p_i^{t-1} q_i^b} \qquad (6.11)$$

6.33 In any given period t the hybrid expenditure shares price-updated to period $t-1$ are used to aggregate elementary price indices. Since hybrid expenditure weights are an estimate of the value of purchasing the quantities from the weight reference period *b* expressed in period $t-1$ prices, they do not reflect changes in consumer purchasing patterns. These are necessary in order to maintain the fixed quantity concept of the Lowe formula.

6.34 In the ongoing practice of compiling the CPI, hybrid expenditure shares (6.11) are not explicitly calculated. Instead, the equivalent Lowe formula is used (6.12), where monthly price relatives $\left(\frac{p_i^t}{p_i^{t-1}}\right)$ multiplied by hybrid expenditure weights expressed at period $t-1$ prices are compared to the hybrid expenditures expressed at period 0 prices in order to obtain price change between period 0 and t.

$$I_{Lo,A}^{0:t} = \frac{\sum_{i=1}^{n}\left(\frac{p_i^t}{p_i^{t-1}}\right)\left(p_i^{t-1}q_i^b\right)}{\sum_{i=1}^{n}\left(p_i^0 q_i^b\right)} = \frac{\sum_{i=1}^{n}\left(\frac{p_i^t}{p_i^{t-1}}\right)\left(\frac{p_i^{t-1}}{p_i^0}\right)\left(p_i^0 q_i^b\right)}{\sum_{i=1}^{n}\left(p_i^0 q_i^b\right)} \qquad (6.12)$$

6.35 Despite all the practical advantages of using the Lowe formula for calculating the upper level of the CPI, it is an asymmetrically weighted price index, meaning that the weights used to aggregate elementary price indices refer to a period preceding the price reference month. For this reason the Lowe formula does not represent the current spending patterns of consumers and therefore is subject to substitution bias.[69]

Contributions to Price Change

6.36 A fixed-basket composite price index for a given aggregate $I_A^{0:t}$ is made up of price indices $I_i^{0:t}$ and weights w_i^0 for the sub-aggregates that are contained in the given aggregate.[70] Therefore it is possible to explain a given aggregate's price change (month-over-month or 12-month) in terms of the influence exerted by its particular sub-aggregates. Analyses of this kind are referred to as contributions to percentage change. Contributions explain how many percentage points of the aggregate's percentage change come from a given sub-aggregate. For example, the gasoline index (a sub-aggregate) contributed 0.5 percentage points to the 1.0 percent change in the all-items CPI.

6.37 The influence exerted by a given sub-aggregate on a composite price change depends on both its price change and on its importance in the basket, as measured by its weight. Calculating contributions to composite price change across chained baskets requires additional steps.[71]

6.38 Any composite price index that relates to one fixed basket can be written as a weighted arithmetic average of the corresponding indices for all its constituent sub-aggregates. In other words, the aggregate index $I_A^{0:t}$ that expresses the change in prices between period 0 and t is a weighted mean of all the indices $I_i^{0:t}$ expressing the change in prices during the same period for all its constituting sub-aggregates.

$$I_A^{0:t} = \sum_{i=1}^{n} I_i^{0:t} \times w_i^{0b} \qquad (6.13)$$

where:

$w_i^{0b} \equiv \frac{p_i^0 q_i^b}{\sum_{i=1}^{n} p_i^0 q_i^b}$ is the hybrid expenditure share,[72]

p_i^0 is the price for sub-aggregate i in period 0;

q_i^b is the quantity for sub-aggregate i in period b, and;

n is the number of sub-aggregates in the aggregate A.

69. The topic of substitution bias in a CPI, as well as the efforts by Statistics Canada to reduce it, are discussed in Chapter 9.
70. The computation of fixed-basket composite price indices is discussed in paragraphs 6.23 to 6.35.
71. This is because chained indices are computed using several fixed baskets; hence there can be no single expression of the importance (weight) of each sub-aggregate. The method for calculating contributions to index percentage change across baskets is discussed in paragraphs 8.22 to 8.24.
72. Hybrid expenditure shares are discussed in paragraphs 6.27 to 6.31.

6.39 Using (2.1), it is possible to decompose the monthly price change of the aggregate index between $t-1$ and t in terms of the monthly change of its sub-aggregates.[73] By construction, the sum of all the sub-aggregates' monthly price changes will be equal to the monthly price change of the aggregate.

$$\left(\frac{I_A^{0:t}}{I_A^{0:t-1}}-1\right)=\frac{I_A^{0:t}-I_A^{0:t-1}}{I_A^{0:t-1}}=\frac{\sum_{i=1}^{n}\left(I_i^{0:t}-I_i^{0:t-1}\right)w_i^{0b}}{I_A^{0:t-1}} \qquad (6.14)$$

where:

$\frac{\left(I_i^{0:t}-I_i^{0:t-1}\right)w_i^{0b}}{I_A^{0:t-1}}$ represents the contribution of each sub-aggregate i to the aggregate A.

6.40 The share of the basket weight w_i^{0b} of the sub-aggregate index i, together with the size and direction of its price change will determine the size and direction of its contribution to the percentage change in the aggregate index A. An increase/decrease in a sub-aggregate index will most often translate into an upward/downward contribution to the aggregate index percentage change.[74] The sum of the contributions of all sub-aggregates of the all-items CPI is equal to its overall rate of change (1-month or 12-month).

6.41 The difference in contributions gives the impact of a sub-aggregate on the difference in the percentage change of its aggregate index. This is commonly referred to as acceleration or deceleration and is obtained by subtracting the contribution in period $t-1$ from the contribution in period t. For example, assuming that the gasoline index contributed 0.5 percentage points in period $t-1$ to the 1.0 percent change in the all-items CPI and in period t contributed 0.7 percentage points to the 1.4 percent change in the all-items CPI, it can be interpreted that the gasoline index contributed 0.2 percentage points (0.7 – 0.5) to the 0.4 percentage point acceleration (1.4 – 1.0) of the all-items CPI between periods $t-1$ and t.

6.42 The analysis provided by Statistics Canada in the various release items for the CPI is based on an understanding of the contributions of sub-aggregate indices to the 1-month or 12-month percentage change in the all-items CPI or another aggregate index.

73. The same exercise can be carried out when analysing the 12-month percent change.
74. The direction of a sub-aggregate's contribution to aggregate index percentage change may be different than the percent change of the sub-aggregate when the period of comparison spans two baskets. The method for calculating contributions to index percentage change across baskets is discussed in paragraphs 8.22 to 8.24.

Chapter 7 – Quality Change and Adjustment

7.1 The Canadian Consumer Price Index (CPI) aims to measure pure price change, that is excluding that portion of price changes that is due to differences in the quality of products purchased by consumers. It achieves this mainly by employing the matched-model method which tracks identical products each month in the same outlets.

7.2 The universe of products bought and sold in the marketplace evolves over time. Updating the sample of items for any given elementary aggregate is inevitable in order to maintain its representativeness. As products in the market change (for example, an old model might be discontinued), observed product offers (PO) may change. It may be important to determine techniques for a valid comparison of prices for the new and the old products. This means that the matched-model framework at times does not hold, and therefore price changes could reflect a mixture of price and quality differences. In order to measure pure price change, quality adjustments are performed.

7.3 There are multiple techniques, both implicit (indirect) and explicit (direct), available to account for quality differences between exiting and entering POs. This chapter will present the different methods used in the CPI.

7.4 It is not always necessary or possible to adjust for quality change when a PO must be replaced in the CPI sample. There are various reasons why adjusting for quality change may not be required and a direct price comparison between entering and exiting POs is the best option. Direct price comparison, an implicit method of quality adjustment, is the simplest approach used in the CPI.

7.5 The CPI employs the direct price comparison method when there is no perceived difference in quality between entering and exiting POs. This method assumes that POs are equivalent in terms of quality.

7.6 The use of the direct price comparison method for these elementary indices is not likely to lead to any systematic bias in the CPI because the majority of these indices fall under one of the following categories.

7.6.1 No appreciable quality change: Many items like gasoline, electricity or natural gas are essentially of the same quality over long periods of time.

7.6.2 Non-market services: Most government-regulated services, such as university education, local transportation or passports, do not receive any treatment for quality change. While it could be argued that the quality of these services may change through time, this is likely to happen very slowly and is difficult to measure. These services are also not available in a competitive market so little can be said about the market valuation of the quality features that are implied.

7.6.3 Bestsellers method: In the case of popular media, such as books, movies or DVDs, it is common international practice to simply aggregate the prices of the top bestsellers and compare the result to that for the previous period's bestsellers, even if these best sellers are different in the two periods. This is because the novelty of the product's content is what is being sought out by consumers, rather than any tangible physical characteristic such as number of pages or quality of the binding, to take books as an example.

7.6.4 The use of the unit value index method also eliminates the need for any further quality adjustment. This index calculation method is rarely used in the CPI and can only be applied in cases where it is assumed that the average quality represented remains constant through time.[75]

75. The unit value method is discussed in paragraph 6.20.

7.7 The use of overlap pricing can also eliminate or significantly reduce the need to make explicit quality adjustments. This implicit method allows for the reduction of unexpected disappearances of sampled POs and ensures that new representative products (RP) can be introduced into the sample before the replaced ones disappear from the market or become unrepresentative. The overlap pricing method is most commonly used in conjunction with the profiles method, enabling the collection of a replacement profile before the obsolescence of an existing one. This method can be used for certain high technology goods (video game consoles, televisions, other consumer electronics), where both new and old models are available on the market during the same months before the disappearance of the old models.

7.8 Overall mean imputation is another implicit method used in the CPI to make quality adjustments between the prices of POs entering and exiting the sample. With this method, the price movement applied to entering POs is based on the observed average price movement of all other POs for the same representative product. Overall mean imputation relies on the assumption that the donor POs are comparable to the PO being imputed.

7.9 The link-to-show-no-change method for quality adjustment, another indirect method, involves forcing a price relative of unity (equals no price change) when replacement POs enter the sample. Currently, this practice is being reduced across the CPI because it introduces a degree of undue price stability in the index.[76]

7.10 Quantity adjustment entails accounting for changes in the quantity (e.g. package size, number of tissue ply, etc.) of observed POs. This is another implicit method of quality adjustment because it is assumed that the quality per standardized unit is the same over time.

7.11 Quantity adjustment is the default treatment for nearly all of the POs in the food major aggregate as well as some of the products in the household operations, and personal care supplies and equipment aggregates.

7.12 For the majority of elementary indices, not covered by the implicit methods described above, it is necessary to make explicit quality adjustments when POs enter or exit the sample.

7.13 To make the appropriate quality comparison, Statistics Canada is usually guided by market valuations of the two POs. Where possible, the two POs are compared in terms of the quality features they offer to consumers. A PO is thought to provide a range of features to the consumer which, grouped together, determine the market price.[77] This general framework is the basis for many of the explicit quality adjustment methods described below.

7.14 The CPI relies on the hedonic quality adjustment technique for certain elementary aggregates, notably in the case of high-technology goods or services. Currently, the CPI uses hedonic quality adjustment for computer equipment, software and supplies, Internet access services, rent, used cars and cellular services from telecommunication service retailers that provide Statistics Canada with their administrative data. The hedonic method of quality adjustment is most appropriate for products whose markets are competitive and experience rapid turnover, and where the characteristics of these products change quickly but are readily and consistently observable.

7.15 The hedonic method is applied in the case of forced replacements. This approach assumes that a relationship exists between the price of a PO and its characteristics. Under the hedonic imputation variant, hedonic specifications have to be defined using standard regression techniques and a previous period price is imputed for the replacement product. In period *t* (when a previously observed PO is no longer available) a regression is used to estimate the unobserved price for the entering PO in period *t*-1. The estimation of the *t*-1 price is based on quality differences between the entering and exiting POs, as well as the *t*-1 price of the exiting PO.

76. ILO *et al*. (2004), paragraph 7.70.
77. The characteristics approach was introduced by Lancaster (1966). Consistent with a characteristics approach, ILO et al. (2004) defines a product, for measurement purposes, as equating to a complete description of its price-determining characteristics. For a CPI program, the demand side of the equation is relevant (consumers' valuation of these characteristics), rather than the supply side (producers' costs or inventory).

7.16 For the computer equipment, software and supplies index, a hedonic adjustment method is used to impute monthly prices of incoming and outgoing items for desktops and laptops. For monitors and printers, which tend to change less frequently, a matched-model price approach is used.

7.17 The log of monthly prices for laptops and desktops are modelled as a function of a set of explanatory variables using a random forest[78] algorithm. While each product has a separate model, the explanatory variables used are mostly the same. The variation in log price is thus explained by characteristics such as storage space, storage type, total Random Access Memory (RAM), type of RAM, display size (for desktops this variable is set to zero if the desktop in question is not an all-in-one desktop), number of Central Processing Unit (CPU) cores, CPU speed, CPU brand, Graphics Processing Unit (GPU) brand, product weight, the presence of a touch screen (laptops only), item manufacturer, and item retailer. For categorical variables, categories with low counts or observations with unknown values are grouped together as 'other'. A model is estimated every month using the latest available data

7.18 For the Internet access services (IAS) elementary index, a pure matched-sample cannot properly account for the rapid technological change and marketing practices that characterize the Internet access industry in Canada. Therefore, a symmetric hedonic method is used to adjust the prices of both entering and exiting Internet access services plans.[79] For the regression model specification, characteristics are transformed as appropriate. Like the method for the computer equipment, software and supplies index, coefficients are estimated at every index calculation period from sets of plans that are used to calculate the index and Internet plan weights.

7.19 For IAS, rather than estimating a single multiple regression, three separate simple regressions are estimated at every index calculation period. In each of these regressions, the dependent variable, log price, is regressed on the intercept term and a single explanatory variable consisting of either log download speed, log upload speed or log usage cap.

7.20 The least squares method is used to solve for the B vector of parameters in the following formulation:

$$\ln p_i^t = B \bullet X_i^t + \varepsilon_i$$

where

p_i^t is the price of plan i from period t ,

ε_i is a random error term with an expected value of zero, and

X_i is plan i 's characteristic (either log download speed, log upload speed or log usage cap).[80]

7.21 Once all three regressions have been estimated, results from each of the regressions are used to predict a price for each plan, leading to three predicted prices. A weighted average of these three predicted prices is calculated as a single predicted price; the weights are defined such that a regression with a higher value of the coefficient of determination R-squared will have more weight. The missing prices of entering and exiting plans are imputed. The missing price of plan i in period t from Internet Service Provider (ISP) h is calculated as $p_{ih}^t = \hat{p}_{ih}^t \times A_{ih}^t$. Here A_{ih}^t is an adjustment factor calculated from the plans available in period t from ISP h while $\hat{p}_{ih}^t$ is the imputed average predicted price.[81] For further details on the adjustment factor, refer to the paper "Internet Access Services Index Methodology in the Consumer Price Index" available online.

78. The random forest method is a statistical prediction method that operates by constructing a set of decision trees and uses the average result of the individual trees to form the prediction.
79. Due to a limited number of observations, provider specific effects cannot be reliably estimated with a linear regression. To account for this, the predicted values of missing plans are adjusted using the residuals of the most similar observed plans.
80. Note the lack of time subscript, t , on the coefficients vector B . This is because the hedonic regression is constrained to hold characteristics coefficients constant across the two time periods.
81. The adjustment factor, A_i^t , does have a time subscript since it is calculated using plans that are available in period, t , where the plan is missing and this factor is expected to account for time specific effects. It does this by incorporating the weighted average residual of the most "similar" plan from period t .

7.22 For the used vehicles price index, a hedonic regression modelling approach is used to account for quality change and depreciation over time. In order to control for quality change and to estimate pure price change, a time dummy hedonic method is employed along a rolling five-month estimation window. Dummy variables for the four latest months[82] of the estimation window, as well as car model fixed effects, are included in the regression. The coefficients of the time dummy variables measure the average price changes of a typical used vehicle (characterized by a given car model, a fixed odometer and a fixed age) in these four months compared to the fifth month of the window. Consequently, the change in the coefficients of dummy variables relating to two consecutive months within an estimation window measures the month over month change in used vehicles' prices – in practice, the CPI uses the differences in the last two dummy coefficients as a measure of monthly price change for a given class of used vehicle. For details about the hedonic model used in the estimation of the used vehicles price index, refer to the paper "Measuring price change for used vehicles in the Canadian Consumer Price Index" available on the Statistics Canada website.

7.23 For the rent index, a hedonic model is estimated using monthly cross-sections of the Labour Force Survey (LFS) data at the national level. The lowest geographical level indices are constructed using average characteristics as quantities and estimated coefficients as prices, while the higher level indices use weighted averages of lower level estimated expenditures.

7.24 The hedonic model for the rent index is a log-linear regression in which the explanatory variables include observed unit characteristics, such as the number of bedrooms, as well as locational characteristics captured by postal codes. The regression specification is as follows:

$$y^* = \beta_0 + \beta_1 services + \beta_2 age + \beta_3 bedrooms + \beta_4 dwelling + \beta_5 FSA + \epsilon$$

where y^* is the log of observed rent, $services$ represents whether the rent cost includes furniture, a washing machine, refrigerator, cable, or heat, age represents the age of building, $bedrooms$ represents the number of bedrooms, $dwelling$ represents the type of the building, and FSA is a vector of dummies defined from the first three digits of the postal code that corresponds to a neighborhood (in urban areas) or a region (in rural areas).

7.25 The option cost method is another explicit approach for making quality adjustments to entering POs in the CPI sample. This technique relies on having data about the specific costs for adding options or quality characteristics to a product. In this explicit method, an adjustment to the last observed price of the exiting PO is made so that it can be compared with the observed price of the entering PO. The option cost method is most commonly used for products where the manufacturer or retailer provides pricing details for the available product characteristics. The CPI has used the option cost method for some time in the elementary aggregates corresponding to the purchase of passenger vehicles index.

7.26 Expert judgment has, in the past, been a predominant practice for explicit quality adjustment in the CPI. This relies upon an employee with expertise in a particular product market to assess and give a valuation to differences in quality between exiting and entering POs. However, the practice of quality adjustment by expert judgment is not arbitrary[83] and follows procedural guidelines for choosing the most plausible quality ratio between exiting and entering POs. The expert judgment method is primarily used for elementary indices under the clothing and footwear major aggregate.

7.27 The option cost and expert judgment explicit approaches to quality adjustment are used in the CPI for cases where a complex decision has to be made, and where it is not appropriate to apply an implicit method such as overall mean imputation.

82. The dummy variable for the first month of the estimation window is excluded to avoid the multicollinearity problem, as the regression model includes an intercept.
83. The expert judgment method has been evaluated internally by Statistics Canada using variance analysis (ANOVA). The goal of this analysis was to test whether average price differed according to the characteristics relied on by the subject matter experts. It was found that in the case of clothing and footwear products, the characteristics used by the experts explained on average 85% of price levels.

Chapter 8 – Weights and Basket Updates

Meaning and Construction of the Consumer Price Index Weights

8.1 The Consumer Price Index (CPI) basket weights are expenditures derived primarily from the Survey of Household Spending (SHS)[84] or from the national/provincial Household Final Consumption Expenditure (HFCE)[85] series for a given reference year.[86] The basket weights are actually hybrid expenditures, meaning that the prices and quantities of the expenditures come from different periods. Hybrid expenditure weights are essential to the fixed basket concept of the CPI.[87]

8.2 The CPI weights are constructed from aggregate household expenditures. This type of weighting, known as plutocratic, implies that each household contributes to the total weight of an elementary aggregate proportionally to their respective spending.[88]

8.3 The HFCE data is used to derive the basket weights for higher level commodity classes, and SHS data used to derive the proportions for the elementary aggregates by mapping the HFCE and SHS estimates to the product and geographical classifications of the CPI. However, the SHS sometimes does not provide sufficient detail and thus basket weights are in some instances constructed from alternative sources.

8.4 The basket weights for the homeowners' replacement cost and mortgage interest cost elementary indices are two examples for which supplementary data are required to construct the weight.[89] Additionally, alternative data sources which include other Statistics Canada surveys, administrative data, and scanner data received from retailers are used to break down aggregate expenditures further for product classes in which the SHS does not provide sufficient detail.[90]

8.5 Supplementary data are also used to confront specific HFCE or SHS expenditure estimates which may be suspected of bias. For example, expenditures for alcohol and tobacco are often thought to be under-reported in household expenditure surveys, as the survey estimates are typically lower than reported in retail sales and government excise tax revenue data.[91]

8.6 At the time of a basket update, Statistics Canada also uses the Bortkiewicz-Szulc decomposition to evaluate expenditures used as basket weights.[92] This method compares relative changes in quantities with the corresponding relative changes in prices in order to assess the reliability of the expenditure weights.

8.7 Assessing the quality of expenditure data also helps Statistics Canada determine the number of basic classes in the CPI (that is, the levels in the product and geographical classifications at which the quantity weights are fixed for the duration of a basket).[93]

8.8 Basic classes are determined based on the availability and quality of the consumer expenditure data as well as the stability of the distribution of spending within elementary aggregates. For example, if the distribution of consumer spending within a given elementary aggregate changes frequently, then it may be advantageous to allow the quantities in the expenditure weight to be updated when new information on consumer spending is available. In such a case Statistics Canada will designate the basic class to be the one above the elementary aggregates where quantities may be updated during the life of the basket.

84. Generally speaking, the SHS is designed to provide information on spending by private households that is detailed enough for, and consistent with, the CPI scope and definitions; see . Statistics Canada, Survey number 3508.
85. HFCE represents the spending of resident households on goods and services they purchase for their own consumption. For further details, refer to the Statistics Canada website. HFCE spending by resident households outside of Canada is not included in the CPI basket weights and spending by non-residents temporarily in Canada is removed from the CPI basket weights as needed.
86. The SHS was the main data source for the CPI basket weight estimation until the 2017 basket. HFCE data were first used in a CPI basket update with the 2020 basket.
87. The calculation of a fixed-quantity-weighted price index is discussed in Chapter 6. The quantities themselves are not directly observed, but are rather implicitly contained in the expenditures.
88. ILO *et al.* (2004), paragraph 18.2.
89. The treatment of owned accommodation in the CPI is discussed in Chapter 10.
90. In order to accurately reflect pandemic-related expenditure shifts at more detailed levels of geography and commodity, the 2021 basket update used national and provincial HFCE data as well as data from the SHS and other alternative sources.
91. The quality of expenditure data are evaluated using outlier detection across basket reference years, microdata analysis, as well as coefficient of variation (CV) analysis.
92. Chaffe *et al*. (2007).
93. The meaning and use of basic classes in the CPI is discussed in Chapter 4.

8.9 The practice of changing the quantities below the basic class level between basket updates provides benefits in that it allows for new information on consumer spending to be incorporated into the CPI in a timely manner.

Updating the Consumer Price Index Basket

8.10 The process of updating the CPI basket is to make the weights assigned to elementary aggregates representative of current consumer spending patterns. In the past, the basket for the CPI was updated every four to five years[94] using new expenditure data from the most recent SHS. Starting with the 2011 basket update, the CPI weights were updated biennially until the 2021 basket update, from which point the basket update is performed on an annual basis. While there is no rule as to how often a CPI basket should be updated, there is general agreement among CPI compilers that more frequent basket updates are preferred.[95]

8.11 In addition to updating and assuring the quality of the weights, the exercise of a basket update also provides an opportunity to review and update other aspects of the indices which may include:

8.11.5 Changing the product and/or geographical classifications to be more representative.

8.11.6 Reviewing and updating the sample of representative products (RP) and outlets.

8.11.7 Updating weights below the elementary aggregate level.

8.11.8 Reviewing methods and concepts for the elementary indices.

8.11.9 Updating documentation and products for dissemination.

8.12 The final stage of a basket update is to chain-link the new fixed-quantity basket to the old fixed-quantity basket in order to produce indices that are a continuous time series. For this reason, the CPI is referred to as a chain of fixed-basket indices.

Chain-linking Indices Across Baskets

8.13 Published consumer price indices are calculated as a chain of fixed-basket indices. This means that a sequence of fixed-basket indices have been chained together to create a continuous time series. This type of chaining is not to be confused with the calculation of monthly chained indices[96] but rather refers to the process of chaining indices across baskets. This is necessary to avoid having breaks in an index when a basket update is performed.

8.14 Chain-linking indices across baskets takes place at the time of a basket update. In order to chain indices across baskets, hybrid expenditure weights for the old and new baskets must be expressed at the prices of a common period. This common period is called the link month.

8.15 Link month weights are obtained by price-updating the original expenditure weights to obtain the hybrid expenditures expressed at prices of the link month.

8.16 Since the basket reference period *b* of the CPI is a *full year*, a process called weight adjustment is necessary to obtain *monthly* hybrid expenditures for the link month. Monthly hybrid expenditures for the link month are calculated in two steps.

8.17 First, the annual expenditures for the basket reference year *b* are divided by the average price change for the basket reference year. This calculation provides a monthly expenditure, called the initial value, for the month preceding the basket reference year *b*. This first step implicitly assumes that the quantities of the basket are constant for each month of the basket reference year.

94. A chronology of basket updates of the CPI up to the 2021 basket is provided in Chapter 11 and Appendix B.
95. Boskin *et al.* (1996) find that more current expenditure weights can reduce the substitution bias in a CPI.
96. The monthly chained form of the Lowe index is discussed in Chapter 6.

8.18 In the second step, the initial values are price updated to the link month in order to express the value of the fixed quantities of the basket at the prices of the link month.[97] Once the link month hybrid expenditures for the new basket are obtained, aggregate indices can be calculated using the new basket.

8.19 In the month following the basket link month, price indices calculated using the new basket are multiplied by the index levels previously published for the old basket.

8.20 Chain-linking of indices is done separately for each basic class.[98] Currently the CPI is published with an index reference period of 2002=100. In 2002 the CPI was based on the 1996 basket. Between the 1996 basket and June 2022, there have been ten basket updates with the following link months:

- 2001 basket linked in December 2002;
- 2001 revised basket linked in June 2004;
- 2005 basket linked in April 2007;
- 2009 basket linked in April 2011;
- 2011 basket linked in January 2013;
- 2013 basket linked in December 2014;
- 2015 basket linked in December 2016;
- 2017 basket linked in December 2018;
- 2020 basket linked in May 2021; and
- 2021 basket linked in April 2022.

8.21 For example, following the introduction of the 2017 basket until the next basket, any chain-linked index with an index reference period of 2002=100 is a chain of nine fixed baskets (8.1).

$$I_{chained}^{2002:t} = I_{2017}^{Dec\,2018:t} \times I_{2015}^{Dec\,2016:Dec\,2018} \times I_{2013}^{Dec\,2014:Dec\,2016} \times I_{2011}^{Jan\,2013:Dec\,2014} \times I_{2009}^{Apr\,2011:Jan\,2013} \times I_{2005}^{Apr\,2007:Apr\,2011} \times I_{2001r}^{Jun\,2004:Apr\,2007} \times I_{2001}^{Dec\,2002:Jun\,2004} \times I_{1996}^{2002:Dec\,2002} \quad (8.1)$$

where:

$I_{chained}^{2002:t}$ is a chained index for the price observation period ***t*** with a price reference period equal to 2002;

$I_{2017}^{Dec\,2018:t}$ is an index for the price observation period *t* with December 2018 as the price reference period, calculated using the 2017 basket;

$I_{2015}^{Dec\,2016:Dec\,2018}$ is an index for December 2018 with December 2016 as the price reference period, calculated using the 2015 basket;

$I_{2013}^{Dec\,2014:Dec\,2016}$ is an index for December 2016 with December 2014 as the price reference period, calculated using the 2013 basket;

$I_{2011}^{Jan\,2013:Dec\,2014}$ is an index for December 2014 with January 2013 as the price reference period, calculated using the 2011 basket;

$I_{2009}^{Apr\,2011:Jan\,2013}$ is an index for January 2013 with April 2011 as the price reference period, calculated using the 2009 basket;

$I_{2005}^{Apr\,2007:Apr\,2011}$ is an index for April 2011 with April 2007 as the price reference period, calculated using the 2005 basket;

97. Statistics Canada publishes two sets of CPI basket weights. One expresses the values of the fixed-quantity basket at basket reference prices and the other at basket link month prices. Statistics Canada, Survey number 2301.
98. It should be noted that the method of chain-linking indices across baskets is such that aggregate indices are not the direct average of their respective sub-indices. In exceptional cases, this may cause the level of an aggregate index to fall slightly outside the range of its sub-indices. ILO *et al.* (2004), paragraph 9.113.

$I_{2001r}^{Jun2004:Apr2007}$ is an index for April 2007 with June 2004 as the price reference period, calculated using the 2001 revised basket; [99]

$I_{2001}^{Dec2002:Jun2004}$ is an index for June 2004 with December 2002 as the price reference period, calculated using the 2001 basket;

$I_{1996}^{2002:Dec2002}$ is an index for December 2002 with 2002 as the price reference period, calculated using the 1996 basket.

Contributions to Index Percentage Change Across Baskets

8.22 The calculation of contributions to percentage change must be modified when the 12-month percentage change of an index spans two baskets, that is, when a basket update was performed between the two periods of comparison (period *t* and period *t*-12). This is because indices chained across baskets are computed using more than one fixed basket. Hence there can be no single expression of the importance (weight) of each sub-aggregate.[100]

8.23 The 12-month contribution to change for a composite price index that is chained across two baskets $\left(\frac{I_A^{0:t}}{I_A^{0:t-12}}-1\right)$ is calculated in two parts. The first relates to the old basket and the second to the new basket.

Unchained indices must be used to derive contributions across baskets (8.2).

$$\left(\frac{I_A^{0:t}}{I_A^{0:t-12}}-1\right)=\underbrace{\left[\sum_i\left(\frac{I_i^{0:link}}{I_i^{0:t-12}}-1\right)\times w_i^{t-12\_old}\right]}_{\text{old basket contributions}}+\underbrace{\left[\sum_i\left(\frac{I_i^{link:t}}{I_i^{link:link}}-1\right)\times w_i^{link\_new}\times I_A^{t-12:link}\right]}_{\text{new basket contributions}} \quad (8.2)$$

$$\text{with} \quad I_i^{link:link}=100$$

where:

$w_i^{t\ 12\_old}$ is the weight of component i according to the old basket valued at the $t-12$ period price;

$w_i^{link\_new}$ is the weight of component i according to the new basket valued at the link month period price; and

$I_A^{t-12:link}$ is the aggregate index in the link month with price reference period $t-12$.

8.24 When calculating contributions to 12-month percentage change on an index that spans across two baskets, it is possible that the summed old basket contributions and summed new basket contributions have opposite signs (+/-). The resulting contribution to the 12-month percentage change in the aggregate index could therefore have the opposite sign of the corresponding 12-month percentage change in the index. In other words, a given sub-aggregate can have a positive 12-month contribution to its aggregate while posting a negative 12-month price change and vice-versa.

99. The basket weights with 2001 reference year were revised in June 2004 following some quality assurance conducted after their introduction in December 2002. This represents the only time CPI basket weights have been revised before the end of the lifespan of the basket.
100. Contributions to price index change are discussed in Chapter 6.

Rebasing an Index

8.25 As discussed in Chapter 2, the index reference period or index base period is the period in which the index is set to equal 100. For the CPI, the index base period is usually a calendar year expressed as "index year=100". Currently the index base period for the CPI is 2002=100. However, the index reference period of the CPI is changed periodically to coincide with the index base period of other major economic indicators produced by Statistics Canada. The process of changing the index base period is known as rebasing.

8.26 There are many reasons why users may need CPI series with index base periods other than those used in the published CPI. For example, they might need a series whose index reference period corresponds to the starting period of a particular wage or payment contract, so they can easily calculate the adjustments to be made. Those interested in comparing consumer price changes between countries might need a CPI series on an index reference period that corresponds with the index base period of another country. The need to change the index base period of CPI series may also result from the technical requirements of an index computation procedure, such as chain-linking across baskets.

8.27 The rebasing of an index (that is, its conversion from one index reference period to another) is an arithmetic operation that does not affect the rate of price change measured by the series between any two periods. To rebase an index $I^{g:t}$ and express it in terms of a new index reference period h, all values in the index time series are divided by a constant. This constant $I^{g:h}$ is an index for price observation period h (which will be the new index reference period) with the initial index reference period g. The calculated results are then multiplied by 100 in order to obtain the new rebased index, with the index for the reference period h equal to 100.

$$I^{h:t} = \frac{I^{g:t}}{I^{g:h}} \times 100 \qquad (8.3)$$

where:

$I^{h:t}$ is the index for a price observation period t with the new index reference period h;

$I^{g:t}$ is the index for a price observation period t with the initial index reference period g; and

$I^{g:h}$ is the index for price observation period h with the initial index reference period g.

8.28 As an example take the all-items CPI for Canada published with an index reference period 2002=100. An extract of this series is shown in Table 8.1 in the column headed $I^{2002:t}$. This index series has been converted into two new index series with index reference periods January 2012=100 and 2012=100 respectively. They are presented in Table 8.1 in the columns headed $I^{Jan\,2012:t}$ and $I^{2012:t}$.

8.29 To calculate $I^{Jan\,2012:t}$ using the original index $I^{2002:t}$ the series is divided by the constant $I^{2002:Jan\,2012}$. To calculate $I^{2012:t}$ using the original index $I^{2002:t}$ the series is divided by the constant $I^{2002:2012}$.

Table 8.1
Example of index rebasing

Index price observation period *t*	$I^{2002:t}$	$I^{Jan\,2012:t}$	$I^{2012:t}$
	120.7	100.0= $\frac{I^{2002:Jan\,2012}}{I^{2002:Jan\,2012}} \times 100 = \frac{120.7}{120.7} \times 100$	99.2= $\frac{I^{2002:Jan\,2012}}{I^{2002:Jan\,2012}} \times 100 = \frac{120.7}{120.7} \times 100$
Jan-12			
Feb-12	121.2	100.4	99.6
Mar-12	121.7	100.8	100.0
Apr-12	122.2	101.2	100.4
May-12	122.1	101.2	100.3
Jun-12	121.6	100.7	99.9
Jul-12	121.5	100.7	99.9
Aug-12	121.8	100.9	100.1
Sep-12	122.0	101.1	100.3
Oct-12	122.2	101.2	100.4
Nov-12	121.9	101.0	100.2
Dec-12	121.2	100.4	99.6
2012 average	121.7	100.9	100.0
Jan-13	121.3	100.5	99.7
Feb-13	122.7	101.7	100.8
Mar-13	122.9	101.8	101.0
Apr-13	122.7	101.7	100.8
May-13	123.0	101.9	101.1
	123.0	101.9= $\frac{I^{2002:Jun\,2013}}{I^{2002:Jan\,2012}} \times 100 = \frac{123}{120.7} \times 100$	101.1= $\frac{I^{2002:Jun\,2013}}{I^{2002:Jan\,2012}} \times 100 = \frac{123}{120.7} \times 100$
Jun-13			

Source: Statistics Canada, CANSIM Table 326-0020.

8.30 Since all indices in any given column of Table 8.1 are derived from original indices with an index reference period 2002=100, divided by a constant, the rate of price change in all the rebased series is the same as in the original series. Small differences in percentage change may result due to rounding when average index values are calculated. It should be noted, however, that differences between index levels, sometimes referred to as differences in index points, vary with the change of the index reference period. Therefore, users who would like to use the CPI for purposes of indexation are advised to use the rate of price change (the percentage change between index values) rather than using the difference in index points.

Chapter 9 – Reliability and Uncertainty

9.1 The Consumer Price Index (CPI) is widely used and trusted by Canadians. The index is never revised, which means it can be used to settle contracts without concern that those contracts may have to be reopened at a later time. The index release dates are typically announced a year in advance and firmly adhered to. The data usually become available three weeks after the price observation period. The index is available in considerable detail and without charge from Statistics Canada.[101]

9.2 As a sample-based statistic, the CPI, like all such statistics, cannot with 100% accuracy estimate the underlying (but unobserved) 'true' value it aims to measure. Nevertheless, the size of any statistical error or bias associated with the CPI is likely to be small enough to be within the range of tolerance of most users.

9.3 This chapter is about the error and bias properties of the CPI. Error refers to non-systematic inaccuracies introduced potentially at all stages of estimation. Errors which are systematic, meaning they lead to consistent over- or under-estimation of the phenomenon being measured, are called biases.[102]

9.4 The goal of this chapter is to inform users about the various ways in which statistical and non-statistical error gets into the CPI and the steps taken by Statistics Canada to minimize the error. The chapter is organized under two main themes. One is the error associated with the estimation of indices at the lower level, while the other discusses the error entering into the calculation of the CPI at the upper level.

Error at the Lower Level of Consumer Price Index Calculation

9.5 Since most elementary price indices are derived from statistical samples, they are subject to sampling errors. These errors will surely have sampling variance[103] and they may also have statistical bias, although efforts are made to minimize any such bias. Other things being equal, a larger sample size should yield a smaller sampling variance for a given elementary index.

9.6 Most of Statistics Canada's surveys have samples drawn randomly from a frame of all in-scope units. Information about the number and size of units in the statistical population makes it possible to analyze the sample properties and calculate estimates of the variance and bias associated with any calculated estimates. If this were the case for the CPI it would be possible to report, for each elementary price index, a corresponding estimate of its sampling variance and bias. However, no comprehensive frame of all consumer products is available and for this reason it is generally not possible to estimate the variance and bias of elementary price indices.

9.7 For a small number of elementary aggregates in the CPI – notably drivers' licenses, passenger and vehicle registration fees – a single price rules the market within each geographical stratum. As a result, these elementary price indices do not have sampling error.

9.8 There are also cases where, although prices vary, information is available on virtually all consumer transactions and therefore estimates of price change have minimal sampling error. An example of such a case is the tuition fees index in the CPI where data are available on prices and enrolment by program for every university.

9.9 In the CPI there are also some elementary price indices that are not calculated via sampling and price observation, but rather by imputation.[104] For the most part these elementary aggregates are individually small residual groupings of products that serve to make the classification exhaustive. The statistical error of these imputed elementary price indices would be similar to those of the donor indices. Since many of these imputed elementary price indices are "catch-all" categories, which are individually small and dispersed across the CPI basket, it is unlikely this estimation method results in a significant increase in the error of the CPI.

101. Availability of the CPI data from Statistics Canada is discussed in Chapter 2.
102. Statistics Canada (2003), paragraph 3.4.2.
103. Sampling variance is the extent to which the estimate of a characteristic from different possible samples of the same size and the same design differ from one another. Statistics Canada (2003), paragraph 3.4.1.
104. The assumption behind the treatment of these elementary aggregates is that the price movements of their unobserved products move in parallel with the price movement of observed products in the donor class. The sampling strategy for the CPI is discussed in Chapter 5.

9.10 In an ideal, simple situation an elementary aggregate would refer to a group of homogenous products and accurate information on the prices and quantities of all consumer transactions would be available in a timely manner. In such a case, the average transaction price (unit value) for one month divided by the average price in the previous month would provide an accurate estimate of price change for the elementary aggregate.

9.11 In reality, product classes are rarely fully homogeneous and full transaction information is rarely available. For this reason elementary price indices must be estimated using sampling methods.[105] Additionally, elementary aggregates in the CPI usually include many varieties of competing products and outlets entering and exiting the market. Because of these complexities, which are common to most elementary aggregates, there is potential for error at the lower level of CPI estimation.

9.12 The general sampling approach for the CPI involves three stages.[106] Two of the stages (geography and outlets) use full or partial frames for the selection of sampling units. However, except for scanner data, there is no comprehensive frame for all products that consumers buy. Therefore, in the vast majority of cases, the third stage, in which representative products (RP) are designated, is done judgmentally. Sampling error can be introduced at any of the stages of the sample selection process. The potential for sampling error is greater in the selection of outlets than in the selection of geographies; it is greatest for product selection because there is no comprehensive frame from which to select units for sampling. Since the CPI sample is selected using some partial frames and judgmental methods it is not possible to estimate accurately the sampling error of elementary price indices.

9.13 Error at the lower-level of the CPI may arise because of delays in introducing new products into the sample in a timely manner. The matched-model approach used in the CPI requires comparison of identical product offers (PO) over time and as a result there is a delay between the time when new products appear in the market and when their corresponding price movements are captured in the CPI. This type of error can never be completely eliminated while continuing to use the matched model approach. However, such errors can be mitigated with improved and timely sample management.[107]

9.14 As with new products, a delay in the introduction of new outlets into the CPI sample can be a source of error. In a competitive retail market, new outlets appear from time to time offering different levels of services or prices. As a result consumers may change where they shop. The CPI does not immediately capture price movements resulting from changes in the retail landscape because the outlet sample is not redrawn every month. As a result, error from outlet substitution can occur.[108] To counteract this type of error, the CPI outlet sample needs to be refreshed frequently to capture price movements in new outlets.

9.15 Bias arising from the emergence of new outlets occurs when new stores enter the market offering lower prices, thereby inducing consumers to switch outlets. Again this is a difficult source of potential bias to avoid completely, but efforts are made to refresh the outlet sample periodically to minimize this kind of bias.

9.16 Other types of error associated with the estimation of elementary price indices include various processing and clerical errors. Error can arise due to the various corrections and adjustments that are made to collected prices. The different methods used to adjust for quality change in the CPI can be imperfect and as such represent a source of error. However, effort is taken to continuously review the methods used and ensure the most appropriate quality adjustment methods are applied. Previous studies have found little indication that quality adjustments across the elementary aggregates of the CPI are consistently biased in an upward or downward direction.[109]

105. The sampling strategy for the CPI is discussed in Chapter 5.
106. The sampling strategy for the CPI is discussed in Chapter 5.
107. The sampling strategy for the CPI is discussed in Chapter 5.
108. Hayman (2006).
109. Rossiter (2005) and Sabourin (2012). Kryvtsov (2013) demonstrates that quality adjustment bias by itself is very small in the CPI.

9.17 Clerical errors might occur when POs are being recorded by the price collection agents. However, efforts are made to minimize errors of this kind. The Computer-Assisted Personal Interview (CAPI) devices used by the price collection agents employ automatic tolerance checks and alert the price collection agents of any suspicious values as they are transcribed. In addition, once the data have been transmitted to Statistics Canada headquarters they are subjected to further verification and analysis. When unusual prices or price movements are detected, subject matter experts sometimes send a "Request for Additional Information" memo back to the price collection agents to obtain additional explanatory information on the PO. The same scrutiny is performed with prices coming from the scanner data, from the web scraped data or from other administrative data sources.

9.18 CPI calculations are carried out with computer software, which largely eliminates the possibility of arithmetic errors. However, the potential for programming errors is present. In 2001 a new methodology was introduced for the traveller accommodation elementary price index and errors were made in programming the algorithm for the new method. When the error was discovered and corrected a few years later, it was found to have caused a downward bias in the elementary index. Since that time, more rigorous testing procedures have been put in place to ensure such errors do not go undetected.

9.19 The CPI sampling strategy makes use of sample frames when selecting geographical collection areas, outlets and some products.[110] These frames can be subject to different types of error. For instance, there are likely to be delays in updating the outlet frame to include new in-scope units and to remove units no longer in scope. In addition, information about the size of individual units – typically sales data – are also subject to possible error. Some of this information comes from administrative data sources such as tax records and some is derived from other Statistics Canada surveys. In either case, the unit size information is typically subject to both sampling and non-sampling error.

Error at the Upper Level of Consumer Price Index Calculation

9.20 The calculation of price indices at the upper level of the CPI is accomplished using the Lowe price index formula. To estimate any particular aggregate index, a weighted average of its component elementary price indices is calculated. There are two possible sources of error in this calculation, both of which relate to the basket weights used in the aggregation. The first refers to errors that could be present in the expenditure estimates used as weights. The second is substitution bias which stems from the use of the Lowe formula at the upper level.

9.21 The Survey of Household Spending (SHS), the Canadian System of National Accounts' (CSNA) estimates of Household Final Consumption Expenditures (HFCE) and additional data sources used to derive the CPI basket weights are all subject to both sampling and non-sampling error.[111] Statistical errors in the CPI basket weights can have an important effect on measured price change for aggregate price indices in the short run. However, empirical studies suggest variations in the basket weights are unlikely to have a big impact on the calculation of the all-items CPI over longer periods of time.[112]

9.22 The other potential source of error with respect to the basket weights is referred to as upper-level substitution bias. This bias arises because of the use of the Lowe formula, which is an asymmetrically weighted fixed-basket price index. Because the weights are obtained from a year that precedes the price reference period, the expenditures are not likely to be fully representative of consumer spending patterns in the price observation periods. This is because consumers tend to adjust their spending habits in response to changes in relative prices, buying more of the products whose prices have fallen or risen less rapidly, while reducing their purchases of products whose prices have increased the most. In other words, they substitute towards relatively cheaper products from relatively more expensive ones. The asymmetrically weighted fixed-basket formula of the CPI does not account for these types of changes in consumer spending until a basket update is performed.

110. The sampling strategy for the CPI is discussed in Chapter 5.
111. The CPI basket weights are discussed in Chapter 8.
112. Chiru (2005).

9.23 Unlike the Lowe formula, there are five known symmetrically weighted price index formulae[113] which are theoretically free from upper level substitution bias. These index formulae use expenditures from both the price reference period 0 and the price observation period *t* and therefore account for product substitutions that consumers may make. In this regard they are representative of consumer spending for the periods in which price change is being calculated.

9.24 While it would be preferable to calculate the CPI using a symmetrically weighted price index formula, current period expenditure weights are not available to support a timely production of the CPI. The non-revision policy[114] of the CPI also does not facilitate the use of forecasted current period expenditures in the calculation of the official CPI.

9.25 While maintaining the use of the Lowe formula, steps are taken to reduce upper level substitution bias by updating the expenditure weights frequently and implementing them with minimal time lag. Statistics Canada took a major step forward in this regard when it switched from a four-year basket update cycle to a two-year cycle with the release of the 2011 basket in March 2013, and then to an annual basket update with the release of the 2021 basket in June 2022. In addition, the lag with which the new basket was implemented was reduced from 18 months to 13 months.[115]

9.26 Upper-level substitution bias in the CPI can be estimated "after the fact" for past periods by comparing the results of the official CPI calculated with the Lowe formula to those calculated using one of the five symmetrically weighted indices, once expenditure data become available.[116]

113. The symmetrically weighted price index formulae are: Fisher, Törnqvist-Theil, Walsh, Drobisch and Marshall-Edgeworth. The results of these indices tend to be extremely close to one another as shown in Huang *et al.* (2017).
114. The availability and non-revision policy of the CPI are discussed in Chapter 2.
115. A chronology of basket updates of the CPI is discussed in Chapter 11.
116. Huang *et al.* (2017).

Chapter 10 – Treatment of Owned Accommodation and Seasonal Products

Concepts Surrounding the Treatment of Owned Accommodation

10.1 The treatment of owned accommodation is one of the most difficult problems encountered when constructing consumer price indices. There is probably no other component that is treated in so many different ways by statistical agencies of various countries. The different treatments are in response to both the complex nature of homeownership, which creates problems in identifying and measuring price changes associated with homeownership, and the diversity of users' requirements with respect to the Consumer Price Index (CPI).[117]

10.2 Conceptually, an owner-occupied dwelling may be regarded as either a capital good or a consumer good, or both. Statistical agencies that adopt the former view exclude owned accommodation from their consumer price indices. In other words, no effect of price changes associated with the cost of purchasing and using owned accommodation is reflected in the CPI.

10.3 Agencies that regard owner-occupied dwellings as consumer goods have several options. One approach is to treat owner-occupied dwellings the same way other durable goods are treated in the CPI, that is, by using the value of net purchases of dwellings in a specified year to derive the basket weight of the index and purchase prices of dwellings to measure price changes for the owned accommodation component.

10.4 A second approach is to take into account the shelter services that are provided by owned accommodation. Since these services, in themselves, are not objects of market transactions, their price movement can only be imputed from other series, such as the rent price index. When this rental equivalence approach is strictly applied, the basket weight assigned to the owned accommodation component is based on the estimated rental value of owner-occupied dwellings. The rental equivalence approach has the merit of being consistent with the conventional treatment of owned accommodation in the "Personal expenditure on consumer goods and services" component of the Canadian System of National Accounts (CSNA).[118]

10.5 Thirdly, the statistical agencies of several countries represent the price movement of the services provided by owner-occupied dwellings with indicators that estimate the effect of price changes on the cost of using dwellings. However, not all countries use the same cost elements. When this user cost approach is applied, the basket weight assigned to owned accommodation is derived from actual or imputed cost elements imputations may be made for unobserved costs such as the forgone interest on the homeowner's capital invested in the dwelling). Some countries decline to include any imputed cost components in the owned accommodation index. Only expenses involving actual cash disbursements are thus included, so this approach is referred to as a money outlays variant of the user cost approach.

10.6 The owned accommodation component seems to be a good illustration of the truism that no single series of consumer price indices can serve well all purposes for which the CPI is commonly used. For example, the rental equivalence approach is fully satisfactory when indices are to be used for deflating the current dollar series within the "Personal expenditure on consumer goods and services" component of the CSNA. This is because the estimated rental value of owner-occupied dwellings is conventionally included in that statistical program. Similarly, if a consumer price index is intended to measure retail price changes, then the movement of current prices of dwellings (and possibly, the movement of current mortgage interest rates) ought to be reflected in the index of owned accommodation.

10.7 Neither of these approaches, however, seems to be particularly suitable for measuring the effect of price changes on the purchasing power of the consumer dollar. The use of the rental equivalence approach for this purpose is questionable, because the purchasing power of homeowners is neither directly dependent on rent changes nor is it necessarily correlated with these changes, especially in the short-to-medium term. The use of current changes in dwelling prices is not appropriate for the above purpose either, because most homeowners continue to pay for their dwellings many years after the purchase. Accordingly, the purchasing power of homeowners at any time is affected by price levels in the dwelling's purchase year, rather than just by those in the current year.

117. Baldwin *et al.* (2009).
118. Statistics Canada (2008).

Treatment of Owned Accommodation in the Consumer Price Index

10.8 The treatment of owned accommodation in the CPI does not truly conform to the basic definition of the CPI as a price index associated with a fixed basket of products purchased by the target population. Moreover, owned accommodation is not treated in the CPI in the same manner as other durable goods. This special treatment is justified by the fact that owner-occupied dwellings have, in general, much longer useful lives, higher values and more complicated terms of payment than other durable goods. Although these differences are of a quantitative rather than of a qualitative nature, they are important enough to be taken into account in the computation of the CPI. For instance, mortgage credit is generally considered to be an integral part of purchasing a home, so it would not be ideal to disregard the effect of changing mortgage interest costs on the overall shelter price index. In addition, since mortgage payments for purchased dwellings are spread over many years, it is desirable to take into account not only their current, but also their previous prices in order to produce an appropriate indicator of price-induced changes in the purchasing power of the consumer dollar. These problems seem to affect other durable goods, including high-value goods such as automobiles, to a lesser extent.

10.9 The treatment of owned accommodation in the CPI follows neither the money outlays approach nor the opportunity cost approach. The owned accommodation index is not a money outlays index because of its replacement cost component, depreciation being an imputed cost rather than an actual expense. The owned accommodation index is not consistent, either, with an opportunity cost approach because it excludes other imputed elements that are generally regarded as part of the opportunity cost, such as forgone interest on invested capital and capital appreciation.

10.10 It follows that the solution to the treatment of owned accommodation is a matter of determining the principal purpose(s) that the CPI is designed to serve. There are several, sometimes competing, uses of the CPI.[119] As with the rest of the index, the approach taken with respect to owned accommodation must attempt to find balance between the purposes for which it serves. The treatment of owned accommodation in the CPI serves well the purpose of providing an adequate indicator of price-induced changes in the purchasing power of the consumer dollar. In particular, it is meant to measure the impact of price changes on a selection of costs specific to homeowners.

10.11 The price index for the owned accommodation aggregate class, like those for other CPI classes, is calculated as a weighted average of elementary indices. Each elementary index represents the price movement for a given element of homeowners' costs. These costs relate to the stock of dwellings that is identical or equivalent to the stock actually owned by the target population at the end of the basket reference period. Thus, the indices for owned accommodation measure price-induced changes in the cost of using a fixed stock of dwellings, while, for other CPI classes, they measure price-induced changes in the cost of buying a fixed basket of goods and services. Six homeowners' costs are included as elementary indices under the owned accommodation aggregate class:

- mortgage interest cost
- replacement cost
- property taxes
- homeowners' home and mortgage insurance
- homeowners' maintenance and repairs
- other owned accommodation expenses

10.12 Until the 2017 CPI basket, except for the mortgage interest cost and the replacement cost index, the basket weights of the owned accommodation components were purely derived from the household expenditures reported in the Survey of Household Spending (SHS). Starting with the 2020 basket, CSNAs' Household Final Consumption Expenditures (HFCE) data and additional data sources replaced the SHS data as the primary data source for most components.

119. The uses of the CPI are discussed in Chapter 2.

10.13 The replacement cost basket weight is partially derived from the SHS while the weights of the mortgage interest cost is estimated using administrative data supplemented by SHS data.

10.14 The basket weight for replacement cost, considered equal to the annual depreciation of the stock of owner-occupied dwellings, is estimated to be 1.5% of the estimated market value of this stock at the end of basket reference year.[120] The estimated market value of the stock of owner-occupied dwellings is derived using a number of statistics including the estimated market value of the stock of owner-occupied dwellings estimated based on the most recent available SHS data, the resale house price change, and the change in owner-occupied dwellings between the latest SHS year and the basket reference year estimated using the CSNAs' housing stock data.

10.15 The basket weight for the mortgage interest cost is the total interest paid on mortgages by Canadian households. In the Canadian CPI, it represents the interest portion of the mortgage payments made by homeowners on the principal dwelling.[121] To estimate its value, administrative data, namely banks' financial statements, collected and published by the Office of the Superintendent of Financial Institutions (OSFI) and SHS data are used.

10.15.1 Based on OSFI data, Statistics Canada estimates the effective interest rate paid on residential mortgages as the ratio of banks' residential mortgage income divided by the banks' total residential mortgage loans in the basket reference period.

10.15.2 The SHS mortgage balances, estimated based on the most recent available SHS data, the resale house price change, and the change in owner-occupied dwellings between the latest SHS year and the basket reference year are used in combination with this effective rate to derive the CPI mortgage interest weights.

10.16 The **mortgage interest cost** index is intended to measure price-induced changes in the amount of mortgage interest owed by the target population. There are two price factors that contribute to these changes through time. First, changes in dwelling prices affect the initial amount of debt; hence they also affect the amount of principal outstanding in subsequent periods. Second, given the amount of principal outstanding, the amount of mortgage interest payments is determined by changes in the price of credit (that is, mortgage interest rates). Consequently, the mortgage interest cost index (with the price observation period t and the price reference period $t-1$) is defined as a product of two indices (10.1).

$$M^{t-1:t} = H^{t-1:t} \times I^{t-1:t} \qquad (10.1)$$

where:

$H^{t-1:t}$ is an index that estimates the effect of changes in dwelling prices on the amount of principal outstanding, assuming a fixed stock of mortgaged dwellings and constant conditions of their financing; and

$I^{t-1:t}$ is an index that estimates the effect of changes in interest rates on the amount of mortgage interest owed, assuming a fixed amount of principal outstanding.

10.17 The index $H^{t-1:t}$ is derived by comparing the average level of dwelling prices in the 25-year interval prior to the price observation period (t) of the index with the average level of dwelling prices in the 25-year interval prior to the price reference period ($t-1$).[122] The procedure is based on the assumption that the dwelling price at the time the debt was initially contracted affects the amount of principal outstanding at any given time. Hence, the total amount of principal currently outstanding for the population of homeowners depends on dwelling prices from all the past periods in which their mortgages were initiated.

120. The value of land is not included in the CPI basket weight for replacement cost. The rationale for using the 1.5% rate can be found in Kostenbauer (2001).
121. Mortgage interest payments on secondary dwellings and rental properties are excluded from the CPI as they are deemed to be outside the consumption basket.
122. The New Housing Price Index (NHPI) published by Statistics Canada (Statistics Canada, Capital Expenditure Price Statistics, Catalogue No. 62-007, Quarterly), the MLS Home Price Index published by the Canadian Real Estate Association as well as the Teranet-National Bank House Price Index are the sources of data on dwelling price movements.

10.18 We assume a standard mortgage amortized over 25 years (300 months) at a fixed rate. The index $H^{t-1:t}$ is defined as follows (10.2):

$$H^{t-1:t} = \frac{\sum_{g=1}^{300}\left(\alpha NHPI_{t+1-g}\left(1-\beta\omega_{RHPI}\right)+\beta RHPI_{t+1-g}\left(1-\alpha\omega_{NHPI}\right)\right)\left(\gamma_g \times \varphi_g\right)}{\sum_{g=1}^{300}\left(\alpha NHPI_{t-g}\left(1-\beta\omega_{RHPI}\right)+\beta RHPI_{t-g}\left(1-\alpha\omega_{NHPI}\right)\right)\left(\gamma_g \times \varphi_g\right)} \quad (10.2)$$

where:

α and β represent dummy variables indicating whether data is available for $NHPI$ and $RHPI$ respectively for a given city or geographical region.

$NHPI_{t+1-g}$ and $NHPI_{t-g}$ are the NHPI respectively for month $t+1-g$ and month $t-g$;

$RHPI_{t+1-g}$ and $RHPI_{t-g}$ are the Resale house price index (RHPI) for month $t+1-g$ and month $t-g$.

ω_{NHPI} and ω_{RHPI} represent the annual weights associated with the value share of new and resale houses respectively, where $\omega_{NHPI}+\omega_{RHPI}=1$;

γ_g represents the proportion of principal that remains to be paid on a mortgage initiated g months ago. This proportion is based on a standard mortgage amortized over 300 months at a fixed interest rate; and

φ_g is the proportion of households that hold a mortgage initiated g months ago. This information is taken from the SHS and would be the only data coming from that survey. It is approximated as of the date on which the household moved into the dwelling.

10.19 Prior to the February 2021 CPI, the model used only the NHPI as a measure of the change in residential housing prices. The NHPI measures the change over time in builders' selling prices of newly built houses in 27 census metropolitan areas (CMA). As of the release of the February 2021 CPI, prices for both new and resale housing are incorporated into the model for the previous 25 years. With the March 2022 CPI release, the Canadian Real Estate Association (CREA) MLS Home Price Index (HPI) replaced Statistics Canada's Residential Property Price Index (RPPI) as the source for resale data. These resale house price indexes are incorporated into the mortgage interest cost model along with the NHPI for all CMAs.

10.20 For the CMAs that include resale data, monthly resale house price index data and NHPI data are combined using a weighted average prior to entering the House sub-index calculation. In general, the resale house price index is allocated a weight of approximately two-thirds, with the remaining one-third assigned to the NHPI. These weights are updated annually.

10.21 The index $I^{t-1:t}$ is derived using two administrative data sets. The first one is produced by the Bank of Canada and provides the amounts of new mortgage loans as well as the corresponding interest rates for the nine largest banks. This dataset allows for monthly update of the mortgage loans by term and covers a large spectrum of interest rates, including variable rates and over 5 years fixed rates. The second source of data is the banks' financial statements collected and published by OSFI.

10.22 It is assumed that the amount of mortgage interest cost at any given time (A_t) depends on interest rates at the time when the current mortgage agreement was contracted. Hence, it is only through new and renegotiated mortgage contracts (L_t) that the current interest rates affect the amount of mortgage interest currently owed by the population of homeowners. A standardized mortgage interest cost function reflects this assumption by considering the initiation and renegotiation of mortgages.

10.23 For any month *t*, the standardized function for the interest payment A_t is derived in two steps according to (10.3).

$$A_t = \sum_{j=1}^{9} \underbrace{\left(L_{j,t} \times r_{j,t}\right)}_{\substack{\text{Amount of interest on} \\ \text{NEW lending} \\ \text{by bank } j}} + \sum_{j=1}^{9} \overbrace{\left[\left(B_j - L_{j,t}\right) \times r_{j,t-1}^{eff}\right]}^{\substack{\text{Amount of interest paid on NON} \\ \text{NEW lending issued by bank } j}} \qquad (10.3)$$

where

A_t is the amount of interest paid in month t ;

$L_{j,t}$ is the amount of new loans issued by the bank j in month t and is obtained from an administrative database produced by the Bank of Canada;

$r_{j,t}$ is the interest rate negotiated by bank j in period t for its new mortgage loans and is obtained from the Bank of Canada administrative data source;

B_j is the balance of mortgage loans issued by the bank j that remains fixed throughout the reference period of the CPI basket to ensure that changes in are solely the result of changes in interest rates and in the distribution of mortgage loans by term; this is obtained from the Bank of Canada administrative data source; and

$r_{j,t-1}^{eff}$ is the effective interest rate in the previous month ($t-1$) for bank j . It is calculated by establishing the ratio between the interest amount for the previous month and the loan balance.

10.24 From (10.3), the index $I^{t-1:t}$, which measures the impact of changes in mortgage interest rates on interest amounts, can be calculated according to (10.4).

$$I^{t-1:t} = \frac{A_t}{A_{t-1}} \qquad (10.4)$$

10.25 The **replacement cost** index relates to that portion of owner-occupied dwellings that is assumed to be consumed. This is represented by the worn-out structural portion of housing (depreciation of housing) or the amount a homeowner must spend to maintain the home's market value. The price index for the replacement cost is derived by taking the total value of homes owned in Canada at the end of the basket reference year and adjusting the total each month by changes in house prices as reflected by a version of the New Housing Price Index (NHPI) which excludes price changes associated with the land (the 'House only' index),[123].

10.26 The **property tax** index measures changes through time in the amount of taxes levied on a constant sample of dwellings in selected municipalities. This sample of property taxes paid, obtained from administrative sources, is used to obtain an estimate of the average property tax by city. This enters as the price in the current and previous periods' unit value index calculation.[124] Changes in property taxes are reflected once a year, in the October CPI.

10.27 The **homeowners' home and mortgage insurance** index measures changes through time in the cost of insuring a fixed stock of dwellings against a specified combination of perils. This cost varies not only with changes in insurance rates for given property values, but also with changes in the values of the properties covered which result from movements in dwelling prices. Consequently, the insurance index is estimated by multiplying the following two indices:

10.27.1 One that measures the change in the value of the replacement cost of properties using a third-party insurance data base (estimated quarterly); and

123. Statistics Canada Survey number 2310.
124. The unit value calculation is discussed in Chapter 6.

10.27.2 One that measures the change in insurance rates by comparing the cost of identical policy profiles using data from insurance companies in the sample. The price of a policy profile is determined based on the value of the structure being insured and on factors that affect the risk of a loss, such as location, type of heating system and the age of the home.

10.28 The elementary indices for homeowners' maintenance and repairs as well as other owned accommodation expenses are estimated using the standard approach for calculating elementary price indices.[125] Data sources for the homeowners' maintenance and repairs sub-indexes include price data collected from retailers and the Construction Union Wage Rate Index. For the other owned accommodation expenses' sub-indexes, which include commissions on the sale of real estate and land transfer costs, the data sources include the NHPI and the Canadian Real Estate Association (CREA)'s MLS home price index (HPI).

Treatment of Seasonal Products

10.29 The use of the fixed-basket concept to construct consumer price indices creates difficulties when the actual consumption pattern in the price observation period differs markedly from that of the basket reference period. In the case of monthly indices, problems may arise due to the seasonality of the quantities consumed of many goods and services. Some products are subject to seasonal variations in their supply. These include various services, such as golf memberships or downhill ski lift tickets that are only available for a few months every year. Other products are subject to seasonal variations in demand. These include many articles of clothing, such as bathing suits and winter coats. Whatever the cause, any good or service that experiences seasonal fluctuations in its quantity purchased should be considered a seasonal product.

10.30 The CPI is based on a fixed-basket, constructed from consumer expenditure data for one year. The representativeness of an annual fixed-basket index in any one particular month is adversely affected if seasonal products are part of the basket. In a fixed-basket index, a seasonal good or service will have the same quantity weight in the basket for all months of the year. That quantity will be inappropriately small in the product's in-season months and inappropriately large in its off-season months. For example, golf membership will be under-weighted in June's CPI, and over-weighted in December's.

10.31 The treatment of seasonal goods and services is a contentious issue. One effective way of dealing with seasonal products in a fixed-basket index with weights from a calendar year is to avoid the inclusion of highly seasonal products in the sample, that is goods or services for which quantity consumed would fall to zero in any particular month(s) of the year. For example, rather than including golf memberships which are unavailable in the winter months, instead the CPI could measure price change of indoor rock climbing passes which are available all year round.

10.32 The main problem with this approach is that it may diminish the representativeness of certain indices in certain months. For example, while the CPI aims to measure price change for all in-scope consumer products, it must inevitably be based on a sample of product offers (PO) for a relatively small number of representative products (RP)[126] that are considered to be representative of all goods and services within a particular elementary aggregate. The problem appears if the price movements of the all-year product, such as indoor rock climbing passes, are not representative of the price movements of all products included in the elementary aggregate. This can become particularly problematic in a country with very distinct seasons, such as Canada, where seasonal products may make up a large proportion of consumer spending. Not including the price movements of seasonal items could lead to some elementary price indices being unrepresentative of price change experienced by the target population for that expenditure category.

125. The standard approach for calculating elementary prices indices in the CPI is discussed in Chapter 6.
126. The CPI price sample is described as small relative to the enormous number of consumer products available. Available resources and other operational and conceptual challenges make it impossible to collect prices for all products bought by Canadian consumers. Furthermore, it is not necessary to sample all products bought by consumers if a representative sample of prices is drawn. The sample strategy for the CPI is discussed in Chapter 5.

10.33 Another option for dealing with the challenges associated with seasonal products is to have separate fixed-quantity baskets for all months of the calendar year (seasonal baskets). That is, to calculate the January index using only the quantities consumed in January, the February index using only the quantities consumed in February, and so forth. Then a seasonal product would have an appropriate quantity weight in every month's index of the year. Annual indices for seasonal products would be calculated as weighted averages of monthly indices so in-season months would be more heavily weighted than off-season months in calculating the annual price movement. If a good or service was a seasonally disappearing product, it would not be part of the basket in a month when it is not available in the market.

10.34 The major disadvantage of an index with seasonal baskets is that it does not provide a measure of pure price change for intra-annual price movements, such as quarterly or monthly changes. First, consider the fixed-basket index with calendar year weights. If the price of every collected PO showed no change in a given month, the index would also show no change. Additionally, if the prices of some collected POs in this fixed-basket index change in a given month, the percentage change of the all-items CPI (or another aggregate index) will lie between the minimum and maximum percentage changes of the corresponding sub-indices. By contrast, if the price of every PO in an index with seasonal baskets showed no price change from month to month, that index may still register an increase or a decrease due to changes in the quantities of the monthly seasonal baskets. Additionally, the monthly percentage change of an all-items CPI (or another aggregate index) with seasonal baskets could sometimes stray outside the minimum and maximum percentage changes of its respective sub-indices.

10.35 Finally, the determination of seasonal basket weights, like all basket weights, is based on consumption patterns from periods in the past and consequently would not take into account abnormal seasonal fluctuations in current periods. For instance, if bad weather conditions in the current period were to impact certain fruit or vegetable crops thereby delaying their availability in the market, seasonal baskets based on past expenditure periods would not account for this.

10.36 The CPI has used two methodologies to deal with seasonal products. From 1961 to April 1973 the CPI series for seasonal food products were based on seasonal-basket formulae.[127] From April 1973 forward all aggregate price indices are calculated using a fixed-basket Lowe price index formula with calendar year weights. Price movements for highly seasonal products are imputed in their out-of-season periods.

10.37 In the current CPI practice, highly seasonal products are identified as such and in the months when their quantity purchased is believed to approximate zero, their price movements are imputed. Examples of products identified as highly seasonal include gas barbeques, lawn mowers, winter jackets and boats. Out-of-season imputations are done at the level of elementary aggregates. The imputed price movement is taken from the aggregate class that is located above the out-of-season product in the CPI classification.

10.38 In the months when indices for out-of-seasonal products are imputed, the price movement for the aggregate index would be exactly the same as if the seasonal product were not part of the basket. Essentially, the basket weights of out-of-season goods and services are redistributed among the remaining in-season products so in this respect, out-of-season imputation, although carried out within the parameters of a fixed-basket index with calendar year weights, gives results similar to the seasonal-basket approach.

10.39 Imputing prices for out-of-season products also helps dampen sharp movements in the index that can occur when moving from one season to the next. This is because the price movement of the product is extrapolated over the out-of-season period rather than being treated as posting no price change. The extent to which out-of-season imputations reduce inter-seasonal shifts in the index depends on the correlation between the price movement of the highly seasonal products and the price movement of the aggregate class that is the source of the imputation.

10.40 It should be clearly understood that the objective of out-of-season imputation is not to obtain a proxy index that mirrors the price behaviour of the seasonal product in its out-of-season months. In many cases, the true price movements of products in their out-of-season months are quite volatile as they are not subject to predictable changes in supply or demand.

127. Statistics Canada (1987).

Seasonal Adjustment of Price Indices

10.41 Month to month movements in the CPI can sometimes be the result of seasonal price changes. For example, between January and March travel packages typically see price increases as more people tend to travel out of the country in the winter and over the March break. While these price changes are valid, in that consumers often experience higher prices for travel tours in the winter months, they are part of a usual pattern of price increases brought on by raised demand. They are likely to be reversed when demand weakens again. Accordingly, for some purposes these price changes might not be interpreted as consumer price inflation. The practice of seasonal adjustment is used to isolate and then remove seasonal price movements from indices to get a better picture of "true" or "underlying" consumer price inflation in the economy.[128]

10.42 Statistics Canada uses the X-12-ARIMA methodology to seasonally adjust the all-items CPI and 12 other aggregate indices at the Canada level.[129] Each month the current index is seasonally adjusted and at the same time the previous month's seasonally adjusted index is open to revision. Additionally, each January the last 36 months of seasonally adjusted data are reviewed and revised.

10.43 Statistics Canada does not seasonally adjust every CPI series. The headline CPI figure is an unadjusted estimate. This is due, in part, to the fact that many users consider the year-over-year percentage change in the all-items CPI to be a good general indicator of consumer price inflation. Year-over-year changes, by their very construction, neutralize most of the seasonal movements and do not require seasonal adjustment.

10.44 The other reason for the limited production of seasonally adjusted CPI data is the properties of the index aggregation formula (Lowe) used to compile the upper level of the CPI. To counteract the potential for residual seasonality in aggregate indices, Statistics Canada employs a direct or independent seasonal adjustment method, meaning that seasonally adjusted CPI series are not derived from their respective seasonally adjusted sub-indices. While this practice reduces the likelihood of having residual seasonality in the series, it also poses a few challenges when using the seasonally adjusted CPI data. First, direct seasonal adjustment prevents consistency in aggregation. Since the all-items CPI is adjusted independently of the eight major aggregates, its movements can be inconsistent with those of its component indices. Second, by directly seasonally adjusting the all-items CPI and major components, the capacity to analyze or interpret contributions to percentage change is lost.

10.45 Despite the challenges with seasonally adjusted price indices, seasonal adjustment provides many useful benefits to users of price indices.[130]

128. While there is no exact definition of "true" or "underlying" price inflation, many economists assert that typical seasonal fluctuations in consumer prices should not be regarded as inflation because when contained within an annual period, they are neutral.
129. The 12 other aggregate price indices seasonally adjusted each month include: the eight major aggregates (food; shelter; household operations, furnishings and equipment; clothing and footwear; transportation; health and personal care; recreation, education and reading; and alcoholic beverages, tobacco products and recreational cannabis); the all-items CPI excluding eight of the most volatile components as defined by the Bank of Canada's definition as well as the effect of changes in indirect taxes; the all-items CPI excluding eight of the most volatile components as defined by the Bank of Canada; the all-items CPI excluding food; and the all-items CPI excluding food and energy.
130. Wyman (2010).

Chapter 11 – History

11.1 The Consumer Price Index (CPI) began with a study conducted by the Department of Labour in the early 1900s. The study was based on a hypothetical family budget that represented weekly expenditures of an urban working man's family of five. Retail prices for 29 food products and 5 fuel and lighting products were collected in approximately 60 cities. In addition, information was obtained on the rent for a representative working man's six-roomed dwelling. Using these data, indices on a 1900 index base period were calculated for Canada and the provinces. The calculation of these indices continued until August 1940.

11.2 The Department of Labour also started producing a "Cost-of-Living Index"[131] on a 1913 index base period, with component indices for food, fuel and lighting, rent, clothing and sundries. This index was published for June and December from 1914 to 1917, for April, June, September and December from 1918 to 1926 and monthly from 1927 onward. An attempt was made to weight product classes according to their actual importance in wage-earners' spending, even though no extensive household expenditure survey had been undertaken.

11.3 The first index of retail prices produced by the Dominion Bureau of Statistics also had a 1913 index base period. This index was calculated using prices from the Department of Labour series as well as some prices obtained directly from retailers. Basket weights used in the index were based on estimates of the total Canadian consumption of each product in 1913. The index was subsequently updated and produced on a 1926 index base period. Although the weighting system of the updated index was more refined, it was still based on the estimated total consumption in Canada. The number of product prices collected increased substantially at this time.

11.4 The index was again updated in 1940 and published on a 1935-39 index base period. The basket weights used in this index were derived from a 1938 Family Expenditure Survey (FAMEX) for urban wage-earner families with annual incomes between $450 and $2,500. The 1940 update showed that the Bureau had come to accept the Department of Labour's view that the index should measure price changes experienced by a well-defined demographic group.

11.5 Until 1940 the CPI was a direct Laspeyres[132] index for its entire or more recent estimation period. Any index can be calculated as a Laspeyres index when it is initiated and until the 1947-48 basket update in 1949, it was considered acceptable to revise the CPI backward for several years at the time of a basket update.[133]

11.6 A subsequent FAMEX covering the period 1947-48 provided the basis for the next thorough basket update of the index in 1952**.** At that time, 1949 became the index base period and the title was changed from "Cost-of-Living Index" to "Consumer Price Index (CPI)".[134] The CPI was defined as "a measure of the percentage change through time in the cost of purchasing a fixed basket of goods and services representing the consumption of a particular population group during a given period of time". This definition remains in essence unaltered to this day.

11.7 Soon after that update, a series of small-scale biennial surveys of family expenditures were undertaken and their results were used to choose the dates of subsequent CPI basket updates. The changes in family expenditure patterns shown by the 1957, 1967 and 1974 surveys were deemed sufficiently important to justify the implementation of new baskets in January 1961, May 1973 and October 1978, respectively.

11.8 Several important changes were introduced with the 1974 basket. In particular, family size and income constraints were removed, thus broadening the target population. Also, with the updating of the 1974 basket the national indices began to be calculated as weighted averages of the corresponding indices for 59 urban centres. In addition, the New Housing Price Index replaced the Residential Building Construction Input Price Index in the CPI series measuring homeowners' replacement cost, mortgage interest cost and homeowners' home and mortgage insurance.

131. Despite the original name, "Cost-of-living-index", the concepts and methodologies used to construct the index never truly conformed to the cost-of-living framework as understood today. Even under its original name, the index was closely tied to the concept of measuring the change in the cost of a fixed basket of goods and services bought by a target population.
132. The index compared prices in a current period *t* to the price reference period *O*, directly rather than via chained-monthly indices as the index is computed today. The methods for computing the CPI are discussed in Chapter 6.
133. This past practice of revising backward at the time of a basket update is contrary to the current no revision policy. The adoption of a no revision policy highlighted the importance of the CPI as a tool in adjusting wages and/or other contractual payments.
134. The original title was inadequate because it led users to believe that the CPI was a measure of all changes in living costs which the index was never designed to do.

11.9 Following the adoption of the 1974 basket in the CPI, a policy of regular updating was established, with the updates tied to a four-year cycle of major FAMEX surveys. The 1978 basket was thus incorporated in April 1982, the 1982 basket in January 1985, and the 1986 basket in January 1989. The time lag between the basket reference period and the implementation of the basket was gradually reduced.

11.10 There was a six-year interval between the 1986 and the 1992 baskets, longer than the regular four-year interval. The introduction of the 1992 basket was postponed by two years to ensure it would reflect adjustments to consumption patterns resulting from the introduction of the Goods and Services Tax (GST) and from the removal of the Federal Sales Tax in January 1991. However, the time lag between the basket reference year and basket implementation remained 24 months for the 1992 basket, which was implemented with the January 1995 update.

11.11 The 1996 basket was introduced with the January 1998 update and was the last basket update that was based on FAMEX data as the survey was subsequently discontinued. The three-year lag between the introduction of the 1996 basket and the introduction of the previous basket was at the time a record for the CPI.

11.12 There was a five-year lag between the 1996 and 2001 baskets, although the basket was introduced with the January 2003 update, matching the record of the 1996 basket update's record for the shortest lag between the end of the basket reference year and the month of implementation. The FAMEX survey was replaced in 1997 with an annual Survey of Household Spending (SHS). Starting with 1999, the SHS estimates were calculated for the provinces and territories in odd-numbered years and for the provinces only in even-numbered years. Since the CPI includes the territorial capitals Yellowknife, Whitehorse and Iqaluit as geographical strata, the year 2000 was precluded as a basket reference year. Budget problems and concerns about year 2000 bugs in computer software also contributed to the choice of 2001 for the basket update.

11.13 The 2005 and 2009 basket updates marked a return to a four year interval between baskets but also a lengthening in the implementation lag: the baskets were implemented in May 2007 and May 2011 respectively.

11.14 The 2011 basket marked the first-ever two-year interval between basket updates for the CPI. It also marked a reduction in the implementation lag to 14 months after the basket reference period, since the new basket was introduced in March 2013 with the release of February 2013 CPI data.

11.15 The 2013, 2015 and 2017 basket updates followed the two-year interval between basket updates and marked a reduction in the implementation lag to 13 month after the basket reference period, since they were respectively introduced in February 2015, February 2017 and February 2019.

11.16 The interval between the 2017 and the 2020 baskets was longer than the regular two-year interval due to the COVID-19 pandemic which affected most of 2020. As a result of the unexpected and profound changes in consumption habits due to the pandemic, the basket weight update, planned for February 2021, was delayed in order to include more recent 2020 national expenditures, rather than solely relying on 2019 expenditures as originally planned.

11.17 The 2020 basket update, introduced in July 2021, marked the introduction of the use of national Household Final Consumption Expenditure (HFCE) series in the CPI expenditure weights estimation, which was planned well before the COVID-19 pandemic. Alternative data sources for 2020 were used to account for pandemic-related shifts at more detailed levels of geography and within the various CPI components.

11.18 The 2021 basket, introduced in June 2022, marked the first ever annual basket update in the CPI. In addition, this corresponds to the shortest interval between two basket updates. The methods and data sources used were similar to those of the 2020 basket update.

11.19 Whenever a basket update takes place, the concepts and the procedures used to calculate the CPI are reviewed and revised when necessary. The CPI index base period has also been periodically changed. While not required to be implemented at the time of a basket update, for operational reasons many of the changes to the CPI index base period have taken place alongside the updating of the basket of goods and services. Changes to the index base period have usually related to changes in the base year of the Canadian System of National Accounts (CSNA).

Glossary

The glossary contains terms that are pertinent to price index theory and the construction of the Canadian Consumer Price Index (CPI).

Term	Description
Acceleration	A larger (faster) rate of change of an index from one period to another. The opposite of deceleration.
Acquisitions approach	An approach to the timing of price collection corresponding to the period in which the good or service is obtained by the consumer, that is, when the legal ownership of the good passes to the consumer.
All-items CPI	The total (highest-level aggregate) in the CPI product classification. The index which is commonly used to calculate “inflation”.
Annual average price index	The unweighted arithmetic average of 12 consecutive monthly price indices from January to December.
Annual average percentage change	The percentage difference between two consecutive annual average prices indices.
Asset	An economic resource. Anything capable of being owned or controlled to produce value and that is held to have positive economic value.
Asymmetrically weighted	Refers to a price index formula where the weights used to aggregate elementary price indices do not give equal weight to both periods of price comparison. For this reason an asymmetrically weighted price index formula does not represent the spending patterns of consumers over both periods of price comparison and is therefore subject to substitution bias. The Laspeyres, Lowe and Paasche formulae are asymmetrically weighted price indices.
Basic class (aggregate)	The lowest level in the intersection of the product and geography classifications at which the quantity weights are kept fixed for the duration of the basket.
Basket update	The process of replacing a basket (fixed-quantity weights) by another one that is more recent.
Basket weight	Expenditures from a given reference period used to estimate quantities consumed for upper level aggregation of elementary price indices.
Bestsellers method	A common method for estimating price change for goods that are highly ‘fashionable’ and have highly intangible content that consumer’s value. The price estimation method currently used for the Books and other reading material (excluding textbooks) elementary index in the CPI.
Bias	Errors which are systematic, meaning they lead to persistent over- or under-estimation of the phenomenon being measured.
Capital good	A durable good that is also an asset.
Chain-linked index	An index spanning more than one basket that has been calculated using the chain-linking procedure.
Chain-linking	The process of chaining a fixed-basket index to another fixed-basket index in order to create a continuous time series. This process ensures that period-over-period percentage changes in a chain-linked index will only reflect price change and not changes in the fixed quantities.
Classification	An exhaustive and mutually exclusive structure for categorizing a domain. In the CPI, classifications are used primarily for the product and geography domains. They are used for weighting and aggregating elementary price indices and also serve as a basis for stratifying the sample of prices collected.
Collection area	A geographical sampling unit. For the CPI it corresponds to a Census Sub-Division and is similar to a “municipality”.
Composite price index	An index designed to express, in one number, average price change for multiple products and/or geographies.
Computer-Assisted Personal Interview (CAPI)	A survey approach where interviewers ask questions guided by a computer screen and enter the responses into the computer, where those answers are checked for consistency and from which the encrypted responses are ultimately transmitted to headquarters.
Consumer goods and services	Products purchased for consumption by a household.
Contribution to percentage change	The percentage points that a change in a component index account for in the percentage change of an aggregate index. It is a tool used by Statistics Canada to understand and summarize movements in the CPI.
Cost-of-Living Index (COLI)	An index designed to measure changes in the cost of maintaining a given level of well-being for a group of consumers.
CPI survey frame	A set of units from which a CPI sample is drawn.
Cut-off sampling	A survey sampling method in which parts of the universe are excluded from sample selection. The method is used by Statistics Canada in the sampling of prices for various elementary aggregates where only partial frames are available.
Deceleration	A smaller (slower) rate of change of an index from one period to another. The opposite of acceleration.
Direct price comparison	A method used to compare the prices of exiting and entering product offers (PO) in the CPI sample when there is no perceptible quality difference. The price of the entering PO is compared directly with the price of the exiting PO and no quality adjustment is made.

Term	Description
Durable good	A good that is not fully consumed in a short period of time (roughly one year). It provides utility over a long period of time.
Economic region	A standard geographical unit, defined by Statistics Canada, for analysis of regional economic activity which corresponds to a grouping of Census Divisions.
Eight major aggregates (components)	The highest level of aggregation in the product classification of the CPI below the all-items level.
Elementary aggregates	The lowest level in the intersection of the product and geographical classifications of the CPI for which expenditure weights are normally available. They consist of similar groupings of products in a geographical stratum. They are the starting point of the upper level aggregation using the fixed-basket Lowe formula.
Elementary product classes	The lowest level in the product classification of the CPI for which expenditure weights are normally available.
Elementary price indices	Price indices corresponding to elementary aggregates. In the CPI they are typically calculated using a Jevons formula.
Explicit quality adjustment	Various methods of directly adjusting an observed price to account for the estimated quality difference between exiting and entering product offers in the CPI sample.
Fixed-basket index	The ratio of the cost of a specified basket of goods and services in a price observation period to its cost in a previous period. The Dutot, Lowe, Laspeyres, Paasche, Marshall-Edgeworth and Walsh formulae yield fixed-basket price indices.
Geographical stratum	The lowest geographical level in which expenditure weights are used in the construction of the CPI. The geographical strata also serve as sampling areas within which product offers are collected for the CPI.
Hedonic quality adjustment	A statistical method for estimating how the price of a product offer (PO) is affected by its characteristics. It is a common method used to estimate the effect of quality change on price movement at the time of PO substitution.
Hybrid expenditures	The value corresponding to the hypothetical cost of an elementary aggregate, in which quantities and prices are derived from different periods. The quantities normally come from the basket reference period and the prices from another period.
Imputation	The process of replacing missing data with estimated values. In terms of the CPI it involves estimating the price movement of an elementary aggregate by proxy, using the price movement of a donor class.
Index reference period (index base period)	The period in which an index is arbitrarily set equal to 100.
Link month	The month in which a new fixed-basket index is chained to an old fixed-basket index.
Link-to-show-no-change	A method which forces a price relative of 1 (no price change) when a new (entering) product offer (PO) replaces an old (exiting) PO in the CPI sample.
Lower level calculation	The first stage of CPI calculation, which involves computing price indices for elementary aggregates. In the case of the CPI this is typically done using a ratio of geometric average prices (Jevons).
Matched-model	A method for measuring “pure price change” by keeping constant all quality characteristics across time, except for price. This is the standard method for measuring price change in elementary aggregates in the CPI.
Money outlays	A variant of the user-cost approach for measuring owned accommodation in a CPI where only expenses involving actual cash disbursements are included.
Month-over-month change	A price change between one month t and the preceding month t-1.
Outlet	The interface between a supplier of products and the consumer. It may be a store, a catalogue, a website etc.
Overlap pricing	A method of quality adjustment based on the difference in price between exiting and entering product offers (PO) when both can be observed simultaneously.
Plutocratic weights	Expenditure weights in which each household in the target population contributes its own spending to the total spending weight for the target population. The basket weights for the CPI, when derived primarily from the Survey of Household Spending, follow this approach. Opposite of democratic weights.
Price observation period	One of the periods for which an index has been compiled. Also widely used to mean the later of the two periods being compared. Appears in the numerator of price ratios. It is typically designated as period t.
Price reference period	The period that provides the prices to which all other periods are compared. Appears in the denominator of price ratios. It is typically designated as period 0.
Price-updating	A procedure whereby the quantities of an earlier period are revalued at the prices of a later period. The result is hybrid expenditure weights. This procedure is necessary in order to hold quantities constant when expenditures (not quantities) are the only source of data available for deriving basket weights.
Product offer (PO)	The presentation of a particular good or service, with an associated price, by a retailer to a purchaser. Used in the CPI as a proxy for the final transaction price paid by consumers.
Profiles method	A method for estimating price change for an elementary aggregate where prices for bundles of services (rather than individual products) are compared over time.

Term	Description
Pure price change	The change in the price of a product of which the characteristics are unchanged; or the change in the price after adjusting for any change in quality.
Quality adjustment	An adjustment to remove from the observed price change the contribution attributable to changes in a product's characteristics.
Rebasing	The process of changing the index reference (base) period. As an arithmetic operation it does not affect the rate of price change between any two index points.
Rental equivalence	The estimation of the hypothetical rents that would be payable by owner-occupiers on the basis of market rents payable for renter-occupied accommodation of the same type and location.
Representative product (RP)	The definition of a narrow class of products for which the average price change is expected to be representative of the average price change of an elementary aggregate.
Sample	A set of data collected to represent a population.
Sampling unit	An element considered for selection in some stage of survey sampling.
Scope	The set of products and geographies and the target population for which the CPI is intended to measure price changes.
Seasonal adjustment	A procedure for removing regular recurring intra-annual fluctuations from a time series in order to reveal its underlying trend, cyclical and irregular movements.
Seasonal product	Products that are either not available for purchase during certain periods of the year or are available but subject to regular and significant fluctuations in the quantities available and/or purchased.
Special aggregate index	An index for different combinations of elementary price indices, excluding certain product classes. These indices provide supplementary information on aggregate price change.
Substitution bias	Generally understood to be the bias that arises from the use of asymmetrically weighted fixed-basket index formulae. Occurs because quantities are held constant while consumers change their purchasing patterns in response to relative price changes.
Symmetrically weighted	Refers to a price index formula where the weights used to aggregate elementary price indices refer to both periods of price comparison. For this reason a symmetrically weighted price index formula represents the spending patterns of consumers over both periods of price comparison and is therefore not subject to substitution bias. The Fisher, Törnqvist-Theil, Walsh and Marshall-Edgeworth formulae are examples of symmetrically weighted price indices.
Target population	The people or group of people whose consumption expenditures are in the scope of the CPI.
Target product offer (TPO)	The specification of a representative product (RP) to an outlet. The TPO acts as the sample intention for the CPI.
Unit value index	A method for estimating price change for an elementary aggregate where the quantity-weighted average transaction price for homogenous products is compared over time.
Upper level calculation	The second stage of CPI calculation, which involves aggregating elementary price indices using a fixed-quantity weighted arithmetic average formula (Lowe).
User cost	The estimation of the cost of using a fixed asset or durable good. The current approach used in the CPI for owned accommodation.
Weight (basket) reference period	The period from which the expenditures, used to derive the quantity weights of the CPI basket, are taken.
Weight adjustment	A procedure to obtain monthly hybrid expenditure weights when annual expenditures are used in the calculation of monthly price indices.

Source: Statistics Canada, Consumer Prices Division.

Appendix – Common Price Index Formulae

Common index formulae for elementary price indices (lower level) between previous period t-1 and current period t

Name	Index formulae	Description
Dutot	$I_{D,a}^{t-1:t} = \frac{\sum_{i=1}^{n} \frac{1}{n} p_i^t}{\sum_{i=1}^{n} \frac{1}{n} p_i^{t-1}}$	A price index defined as the ratio of the unweighted arithmetic average of the prices in the current period *t* to the unweighted arithmetic average of the prices in period *t*-1. See chapter 6, formula 6.3.
Jevons	$I_{J,a}^{t-1:t} = \frac{\prod_{i=1}^{n} (p_i^t)^{1/n}}{\prod_{i=1}^{n} (p_i^{t-1})^{1/n}}$	A price index defined as the ratio of the unweighted geometric average of the prices in the current period *t* to the unweighted geometric average of the prices in period *t*-1. See chapter 6, formula 6.2.
Weighted Jevons	$I_{WJ,a}^{t-1:t} = \frac{\prod_{i=1}^{n} \left(p_i^t\right)^{w_i / \sum_{i=1}^{n} w_i}}{\prod_{i=1}^{n} \left(p_i^{t-1}\right)^{w_i / \sum_{i=1}^{n} w_i}}$	A price index defined as the ratio of the explicitly weighted geometric average of the prices in the current period *t* to the explicitly weighted geometric average of the prices in period *t*-1. See chapter 6, formula 6.4.

Common index formulae for aggregate price indices (upper level) between the price reference period 0 and current period t

Name	Index formulae	Description
Fisher	$I_{\mathrm{F},A}^{0:t} = \left(I_{L,A}^{0:t} \cdot I_{\mathrm{P},A}^{0:t}\right)^{\frac{1}{2}}$	A price index defined as a geometric average of the Laspeyres price index and the Paasche price index. It is a symmetrically weighted index using quantities of goods and services from both periods 0 and *t*.
Laspeyres	$I_{L,A}^{0:t} = \frac{\sum_{i=1}^{n} p_i^t q_i^0}{\sum_{i=1}^{n} p_i^0 q_i^0}$	A price index defined as an asymmetrically weighted fixed-basket index that uses the quantities of goods and services from the base period 0. See chapter 6, formula 6.5.
Lowe	$I_{Lo,A}^{0:t} = \frac{\sum_{i=1}^{n} p_i^t q_i^b}{\sum_{i=1}^{n} p_i^0 q_i^b}$	A price index defined as an asymmetrically weighted fixed-basket index that uses the quantities of goods and services from the chosen weight reference period *b*. See chapter 6, formula 6.6.
Marshall-Edgeworth	$I_{ME,A}^{0:t} = \frac{\sum_{i=1}^{n} p_i^t \cdot \left[\frac{\left(q_i^0 + q_i^t\right)}{2}\right]}{\sum_{i=1}^{n} p_i^0 \cdot \left[\frac{\left(q_i^0 + q_i^t\right)}{2}\right]}$	A price index defined as the ratio of average weighted prices between period 0 and *t* with weights as the arithmetic average of quantities from both periods 0 and *t*. It is a symmetrically weighted fixed-basket index.

Common index formulae for aggregate price indices (upper level) between the price reference period 0 and current period t

Name	Index formulae	Description
Paasche	$I_{\mathrm{P},A}^{0:t} = \frac{\sum_{i=1}^{n} p_i^t q_i^t}{\sum_{i=1}^{n} p_i^0 q_i^t}$	A price index defined as an asymmetrically weighted fixed-basket index that uses the quantities of goods and services from the current period *t*.
Törnqvist-Theil	$I_{T,A}^{0:t} = \prod_{i=1}^{n} \left(\frac{p_i^t}{p_i^0}\right)^{\frac{1}{2}\left(s_i^0 + s_i^t\right)}$ Where $s_i^0 = \frac{p_i^0 q_i^0}{\sum_{i=1}^{n} p_i^0 q_i^0}$ $s_i^t = \frac{p_i^t q_i^t}{\sum_{i=1}^{n} p_i^t q_i^t}$	A price index defined as a geometric average of price relatives weighted by the average expenditure shares in both periods 0 and *t*. It is a symmetrically weighted index.
Walsh	$I_{W,A}^{0:t} = \frac{\sum_{i=1}^{n} p_i^t \sqrt{q_i^t q_i^0}}{\sum_{i=1}^{n} p_i^0 \sqrt{q_i^t q_i^0}}$	A price index defined as the ratio of average weighted prices between period 0 and *t* with weights as the geometric average of quantities from both periods 0 and *t*. It is a symmetrically weighted fixed-basket index.

Source: Statistics Canada, Consumer Prices Division.

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