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Dedication

This piece of academic research is dedicated first to my dear Father, Soh Morlai Bangura, who since my formative years impressed in my mind the importance of getting a better education. To my uncles Honorable Husman Sahid Kanu (Late), and Dr. Alim Bangura, Chief Economist Ministry of Finance that have also been supportive. And to my children Alim Nabie Bangura, and Nanet M.D Bangura, with the fervent hope that both of you become better scholars than me.

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Chapter 1

1.0 Introduction

Consumer Price Index (CPI) is a statistical estimate constructed using the prices of a sample of representative items whose prices are collected periodically. Sub-indices and sib-sub-indices can be computed for different categories and sub-categories of goods and services, being combined to produce the overall index with weights reflecting their shares in the total of the consumer expenditures covered by the index. It is one of several price indices calculated by most national statistical agencies. The annual percentage change in a CPI is used as a measure of inflation. A CPI can be used to index (i.e. adjust for the effects of inflation) the real value of wages, salaries, and pensions; to regulate prices; and to deflate monetary magnitudes to show changes in real values. In most countries the CPI is one of the most closely watched national economic statistics. Inflation measured by consumer price index (CPI) is defined as the change in the prices of a basket of goods and services that are typically purchased by specific groups of households. Inflation is measured in terms of the annual growth rate and in index, 2015 base year with a breakdown for food, energy and total excluding food and energy. Inflation measures the erosion of living standards. When the CPI is rising it means that consumer prices are also rising, and when it falls it means consumer prices are generally falling. In short, a higher CPI indicates higher inflation, while a falling CPI indicates lower inflation, or even deflation. The CPI is constructed to focus on the buying habits of urban consumers. It has often been criticized as not providing an accurate measure of either the prices of goods or the consumer buying habits of more suburban or rural areas.

The index is usually computed monthly, or quarterly I some countries, as a weighted average of sub-indices for different components of consumer expenditure, such as food, housing, shoes, clothing, each of which is, in turn, a weighted average of sub-sub-indices. At the most detailed level, the elementary aggregate level, (for example, men's shirts sold in department stores in San Francisco), detailed weighting information is unavailable, so indices are computed using an unweighted arithmetic or geometric mean of the prices of the sampled product offers. (However, the growing use of barcode scanner data is gradually making weighting information available even at the most detailed level.) These indices compare prices each month with prices in the price-reference month. The weights used to combine them into the higher-level aggregates, and then into the overall index, relate to the estimated expenditures during a preceding whole year of the consumers covered by the index on the products within its scope in the area covered. Thus the index is a fixed-weight index, but rarely a true Laspeyres index, since the weight-reference period of a year and the price-reference period, usually a more recent single month, do not coincide. The Consumer Price Index (CPI) is a measure of the average change over time in the

prices paid by consumers for a representative basket of consumer goods and services. The CPI measures inflation as experienced by consumers in their day-to-day living expenses, which is an instrument to measure inflation, it is used to estimate the average variation between two given periods in the prices of products consumed by households, in other words CPI is a composite measurement of trends in the prices of products at constant quality.

Ideally, the weights would relate to the composition of expenditure during the time between the price-reference month and the current month. There is a large technical economics literature on index formulas which would approximate this and which can be shown to approximate what economic theorists call a true cost-of-living index. Such an index would show how consumer expenditure would have to move to compensate for price changes so as to allow consumers to maintain a constant standard of living. Approximations can only be computed retrospectively, whereas the index has to appear monthly and, preferably, quite soon. Nevertheless, in some countries, notably in the United States and Sweden, the philosophy of the index is that it is inspired by and approximates the notion of a true cost of living (constant utility) index, whereas in most of Europe it is regarded more pragmatically. The coverage of the index may be limited. Consumers' expenditure abroad is usually excluded; visitors' expenditure within the country may be excluded in principle if not in practice; certain groups such as the very rich or the very poor may be excluded. Saving and investment are always excluded, though the prices paid for financial services provided by financial intermediaries may be included along with insurance.

The index reference period, usually called the base year, often differs both from the weight-reference period and the price-reference period. This is just a matter of rescaling the whole time series to make the value for the index reference-period equal to 100. Annually revised weights are a desirable but expensive feature of an index, for the older the weights the greater is the divergence between the current expenditure pattern and that of the weight reference-period. It is calculated and reported on a per region or country basis on a monthly and annual basis. International organizations like the Organization for Economic Co-operation and Development (OECD) report statistical figures like the consumer price index for many of its member countries. In the U.S. the CPI is usually reported by the Bureau of Labor Statistics. An English economist by the name of Joseph Lowe first proposed the theory of price basket index in 1822. His fixed basket approach was relatively simple as Lowe computed the price of a list of goods in period 0 and compared the price of that same basket of goods in period 1. Since his proposed theories however were elementary, later economists built on his ideas to form our modern definition. The aggregate index for any given month is computed as a quantity-weighted acerage of the current month index divided by the index value in the index base period. Month-to-month price change is then calculated as a ratio of the long-term monthly indexes.

Calculating the consumer price index (CPI) for a single item:

Consumer price index = market basket of desired year X 100 Or

Market basket of base year

$\frac{CPI_2}{CPI_1} = \frac{Price_2}{price_1}$ Where 1 is usually the comparison year and CPI_1 is usually an index of 100.

Alternatively, the CPI can be performed as

$CPI = \frac{\text{updated cost}}{\text{Base period cost}} \times 100$

The "updated cost" (i.e. the price of an item at a given year)

The "updated cost" (i.e. the price of an item at a given year, e.g.: the price of bread today) is divided by that of the initial year (the price of bread in 1970), then multiplied by one hundred. There are three reasons why the CPI is hard to measure accurately: First, the substitution bias, the problem with the CPI is the substitution bias. The Second problem with the CPI IS the introduction of new items. The third problem with the CPI is quality changes, that changes in the quality of goods and services are not well handled. The CPI represents changes in prices of all goods and services purchased for consumption by urban households. User fees (such as water and sewer service) and sales and excise taxes paid by the consumer are also included. Income taxes and investment items (like stocks, bonds, and life insurance) are not included.

Calculating the CPI for multiple items:

Many but not all price indices are weighted averages using weights that sum to 1 or 100.

Example: The price of 85,000 items from 22,000 stores, and 35,000 rental units are added together and averaged. They are weighted this way housing 41.4 percent; food and beverages 17.4 percent; transport 17.0 percent; medical care 6.9 percent. Taxes (43 percent) are not included in the CPI computation.

$CPI = \frac{\sum_{i=1}^{n} CPI_I \times weight_i}{\sum_{i=1}^{n} weight_i}$ Where the $Weight_i$ term do not necessarily sum up to 1 or 100

The Consumer Price Index **(CPI)** is a measure of the average change over time in the prices paid by urban consumers for a market basket of consumer goods and services. In the U.S. The Consumer Price Index measures the monthly change in prices paid by U.S. consumers. The Bureau of Labor Statistics (BLS) calculates the CPI as a weighted average of prices for a basket of goods and services representative of aggregate U.S. consumer spending. The CPI is one of the most popular measures of inflation and deflation. The CPI report uses a different survey methodology, price samples, and index weights than the producer price index (PPI), which measures changes in the prices received by U.S. producers of goods and services**.** For example in the U.S. The Consumer Price Index rose by 10.1 percent in the 12 months to January 2023, down from 10.5 percent in December 2022. On a monthly basis, CPI fell by 0.6 percent in January

2023, compared with a fall of 0.1 percent in January 2022. The CPI –U increased 6.4 percent over the 12-month period ending January 2023; increasing 0.5 percent in January compared to with a 0.1 percent increase in December 2022. Inflation is an increase in the overall price level, the official inflation rate is tracked by calculating changes in a measure called the consumer price index. The CPI tracks changes in the cost of living over time. Inflation is an increase in the overall price level. The official inflation rate is tracked by calculating changes in a measure called the consumer price index (CPI). The CPI tracks changes in the cost of living over time. The Consumer Price Index (CPI) is an index that is often used to measure inflation by tracking the changes over time in the prices paid by consumers for a basket of goods and services.

The BLS collects about 80,000 prices monthly from some 23,000 retail and service establishments. Although the two CPI indexes calculated from the data both contain the word urban, the more broad-based and widely cited of the two covers 93 percent of the U.S. population. Shelter category prices accounting for a third of the overall CPI are based on a survey of rental prices for 50,000 housing units, which is then used to calculate the rise in rental prices as well as owners' equivalents. The owners equivalent category models the rent equivalent for owner-occupied housing to properly reflect housing costs' share of consumer spending. User fees and sales or excise taxes are included, while income taxes and the prices of investments such as stocks, bonds, or life insurance policies are not part of the CPI. The calculation of the CPI indexes from the data factors in substitution effects – consumers' tendency to shift spending away from products and categories has grown relatively more expensive. It also adjusts price data for changes in product quality and features. The weighting of the product and service categories in the CPI indexes corresponds to recent consumer spending patterns derived from a separate survey. The Consumer Price Index (CPI) is a measure of the average change over time in the prices paid by urban consumers for a market basket of consumer goods and services. Indexes are available for the U.S and various geographic areas. Average price data for select utility, automotive fuel, and food items are also available.

The BLS publishes two indexes each month. * The Consumer Price Index for All Urban Consumers (CPI-U) represents 93 percent of the U.S population not living in remote rural areas. It does not cover spending by people living in farm households, institutions, or on military bases. CPI-U is the basis of the widely reported CPI numbers that matter to financial markets. The BLS also publishes the Consumer Price Index for Urban Wage Earners and Clerical Workers (CPI-W). * The BLS also publishes the Consumer Price Index for Urban Wage Earners and Clerical Workers (CPI-W). The CPI-W covers 29 percent of the U.S population living in households with income derived predominantly from clerical employment or jobs with an hourly wage. CPI-W is used to adjust Social security payments as well as other federal benefits and pensions for changes in the cost of living. It also shifts federal income tax brackets to ensure taxpayers are not subjected to a higher marginal rate as a result of inflation. A consumer price index (CPI) as the name implies is a price index, the price of a weighted average market basket of consumer goods

and services purchased by households. Changes in measured CPI track changes in prices over time.

Consumer price indexes (CPIs) are index numbers that measure changes in the prices of goods and services purchased or otherwise acquired by households, which households use directly, or indirectly, to satisfy their own needs and wants. In practice, most CPIs are calculated as weighted averages of the percentage price changes for a specified set, or 'basket', of consumer products, the weights reflecting their relative importance in household consumption in some period. CPIs are widely used to index pensions and social security benefits. They are also used to index other payments, such as interest payments or rents, or the prices of bonds. CPIs are also commonly used as a proxy for the general rate of inflation, even though they measure only consumer inflation. They are used by governments or central banks to set inflation targets for purposes of monetary policy. The price data collected for CPI purposes can also be used to compile other indices, such as the price indices used to deflate household consumption expenditures in national accounts, or the purchasing power parities used to compare real levels of consumption in different countries.

The more common CPI-U calculations entail two primary formulas. The first is used to determine the current cost of the weighted-average basket of products, while the second is used to analyze the year-over-year change. The Annual CPI Formula is used to calculate the annual CPI, the BLS divides the value of a specific basket of goods today compared to one year ago: Annual CPI = Va/Vo. As mentioned earlier, the basket of goods and services used in the CPI calculation is a composite of popular items commonly purchased by Americans (consumers). The weight of each component of the basket is in proportion to how they are sold. The annual CPI is reported as a whole number, and the figure is often greater than 100 (assuming current prices are appreciating). Then, the BLS uses the current year's CPI and the prior year's CPI to calculate the inflation rate. Inflation Rate = Ya/Yo. The inflation rate can be calculated for a given month or annual period; in either case, the appropriate new and prior period must be selected. The inflation rate is reported as a percentage and is often positive (assuming current market prices are appreciating).

CPI Categories: The monthly CPI release from the BLS leads with the change from the prior month for the overall CPI-U as well as its key subcategories, along with the unadjusted change year-over-year. The bureau's detailed tables show price changes for a variety of goods and services organized by eight umbrella spending categories. Sub-categories estimate price changes for everything from tomatoes and salad dressing to auto repairs and sporting events tickets. Price change for each subcategory is provided with and without seasonal adjustment. In addition to the national CPI indexes, BLS publishes CPI data for U.S. regions, sub-regions, and major metropolitan areas. The metro data is subject to wider fluctuations and is useful mainly for identifying the price changes based on local conditions. The table below represents the CPI basket weighted distribution amongst the eight major expense categories. Be mindful that some

subcategories may be difficult to spot within their major categories. For example, automobiles are classified under commodities.

CPI Categories by Weight as of February 2023

Group	Weight
Housing	34.4%
Food	13.5%
Transportation	5.7%
Commodities	21.3%
Health Care	6.6%
Energy	7.1%
Education	4.9%
Other Expenses	6.5%
Total Expenses	100%

Source: US Bureau of Labor Statistics.

In an effort to further coordinate and harmonize the collection of CPI data, the international organizations agreed that the International Monetary Fund (IMF) and the Organization for Economic Cooperation and Development (OECD) would assume responsibility for the international collection and dissemination of national CPI data. Under this data collection initiative, countries are reporting the aggregate all items index; more detailed indexes and weights for 12 sub-groups of Consumption expenditure (according to the so-called COICOP – classification), and detailed metadata. These detailed data represent a valuable resource for data users throughout the world and this portal would not be possible without the ongoing cooperation of all reporting countries. In this effort, the OECD collects and validates the data for their member countries, including accession and key partner countries, whereas the IMF takes care of the collection of data for all other countries.

Inflation Forecast is measured in terms of the consumer price index (CPI) or harmonized index of consumer prices (HICP) for euro area countries, the euro area aggregate and the United Kingdom. Inflation measures the general revolution of prices. It is defined as the change in the prices of a basket of goods and services that are typically purchased by households. Projections are based on an assessment of the economic climate in individual countries and the world economy, using a combination of model-based analyses and expert judgment. The indicator is expressed in annual growth rates.

Producer Price Indices (PPI) in manufacturing measure the rate of change in prices of products sold as they leave the producer. They exclude any taxes, transport and trade margins that the purchaser may have to pay. PPI provide measures of average movements of prices received by the producers of various commodities. They are often seen as advanced indicators of price changes throughout the economy, including changes in the prices of consumer goods and services. Manufacturing covers the production of semi-processed goods and other intermediate

goods as well as final products such as consumer goods and capital equipment. A variety of price indices may be used to measure inflation in an economy. These include consumer price indices (CPI), price indices relating to specific goods/or services, GDP deflators and producer price indices (PPI). This indicator is presented for total market and domestic market and is measured in terms of the annual growth rate and in index. **Comparative price level indices** are the ratios of purchasing power parities to market exchange rates. At the level of GDP, comparative price levels provide a measure of the differences in the general price levels of countries. This indicator is measured as an index.

Housing Prices include housing rent prices indices, real and nominal house prices indices, and ratios of price to rent and price to income. In most cases, the nominal house price index covers the sales of newly-built and existing dwellings, following the recommendations from the RPPI (Residential Property Prices Indices) manual. The real house price index is given by the ratio of the nominal house price index to the consumers' expenditure deflator in each country from the OECD national accounts database. Both indices are seasonally adjusted. The price to income ratio is the nominal house price index divided by the nominal disposable income per head and can be considered as a measure of affordability. The price to rent ratio is the nominal house price index divided by the housing rent price index and can be considered as a measure of the profitability of house ownership. The price to income and price to rent ratios are indices with base year 2015.

Share Prices: Share price indices are calculated from the prices of common shares of companies traded on national or foreign stock exchanges. They are usually determined by the stock exchange, using the closing daily values for the monthly data, and normally expressed as simple arithmetic averages of the daily data. A share price index measures how the value of the stocks in the index is changing, a share return index tells the investor what their "return" is, meaning how much money they would make as a result of investing in that basket of shares. A price index measures changes in the basket capitalization of the basket of shares in the index whereas a return index adds on to the price index the value of dividend payments, assuming they are re-invested in the same stocks. Occasionally agencies such as central banks will compile share indices.

Weights and sub-indices: By convention**,** weights are fractions or ratios summing to one, as percentages summing to 100 or as per mille numbers summing to 1000. On the European Union's Harmonized Index of Consumer Prices (HICP), for example, each country computes some 80 prescribed sub-indices, their weighted average constituting the national HICP. The weights for these sub-indices will consist of the sum of the weights of a number of component lower level indices. The classification is according to use, developed in a national accounting context. This is not necessarily the kind of classification that is most appropriate for a consumer price index. Grouping together of substitutes or of products whose prices tend to move in parallel might be more suitable.

For some of these lower-level indices detailed reweighting to make them be available, allowing computations where the individual price observations can all be weighted. This may be the case, for example, where all selling is in the hands of a single national organization which makes its data available to the index compilers. For most lower level indices, however, the weight will consist of the sum of the weights of a number of elementary aggregate indices, each weight corresponding to its fraction of the total annual expenditure covered by the index. An 'elementary aggregate' is a lowest-level component of expenditure: this has a weight, but the weights of each of its sub-components are usually lacking. Thus, for example, weighted averages of elementary aggregate indices (e.g. for men's shirts, raincoats, women's dresses, etc.) make up low-level indices (e.g. outer garments). Weight averages of these, in turn, provide sub-indices at a higher, more aggregated level (e.g. clothing) and weighted averages of the latter provide yet more aggregated sub-indices (e.g. clothing and Footwear).

Some of the elementary aggregate indices and some of the sub-indices can be defined simply in terms of the types of goods and/or services they cover. In the case of such products as newspapers in some countries and postal services, which have nationally uniform prices. But where price movements do differ or might differ between regions or between outlet types, separate regional and/or outlet-type elementary aggregates are ideally required for each detailed category of goods and services, each with its own weight. An example might be an elementary aggregate for sliced bread sold in supermarkets in the Northern region. Most elementary aggregate indices are necessarily 'unweight' averages for the sample of products within the sampled outlets. However, in cases where it is possible to select the sample of outlets from which prices are collected so as to reflect the shares of sales to consumers of the different outlet types covered, self-weighted elementary aggregate indices may be computed. Similarly, if the market shares of the different types of products represented by product types are known, even only approximately, the number of observed products to be priced for each of them can be made proportional to those shares.

Estimating Weights: The outlet and regional dimensions noted above mean that the estimation of weights involves a lot more than just the breakdown of expenditure by types of goods and services, and the number of separately weighted indices composing the overall index depends upon two factors:

1. The degree of detail to which available data permit breakdown of total consumption expenditure in the weight reference-period by type of expenditure, regional and outlet type.
2. Whether there is reason to believe that price movements vary between these most detailed categories.

How the weights are calculated, and in how much detail, depends upon the availability of information and upon the scope of the index. In the U.K the retail price index (RPI) does not relate to the whole of consumption, for the reference population is all private households that

derive at least three-quarters of their total income from state pensions and benefits, and "high income households" whose total household income lies within the top four per cent of all households. The result is that it is difficult to use data sources relating to total consumption by all population groups. For products whose price movements can differ between regions and between different types of outlet:

- The ideal, rarely realizable in practice, would consist of estimates of expenditure for each detailed consumption category, for each type of outlet, for each region.
- At the opposite extreme, with no regional data on expenditure totals but only on population (e.g. 24 percent in the Northern region) and only national estimates for the shares of different outlet types for broad categories of consumption (e.g. 70 percent of food sold in supermarkets) the weight for sliced bread sold in supermarkets in the Northern region has to be estimated as the share of sliced bread in total consumption X 0.24 X 0.7. The situation in most countries comes somewhere between these two extremes. The point is to make the best use of whatever data are available.

  The nature of the data used for weighting: No firm rules can be suggested on this issue for the simple reason that the available statistical sources differ between countries. However, all countries conduct periodical household-expenditure surveys and all produce breakdowns of consumption expenditure in their national accounts. The expenditure classifications used there may however be different. In particular:

- Household-expenditure surveys do not cover the expenditures of foreign visitors, though these may be within the scope of a consumer price index.

- National accounts include imputed rents for owner-occupied dwellings which may not be within the scope of a consumer price index.

Even with the necessary adjustments, the national account estimates and household-expenditure surveys usually diverge.

The statistical sources required for regional and outlet-type breakdowns are usually weak. Only a large-sample Household Expenditure survey can provide a regional breakdown. Regional population data are sometimes used for this purpose, but need adjustment to allow for regional differences in living standards and consumption patterns. Statistics of retail sales and market research reports can provide information for estimating outlet-type breakdowns, but the classifications they use rarely corresponds to COICOP categories. The increasingly widespread use of bar codes, scanners in shops has meant that detailed cash register printed receipts are provided by shops for an increasing share of retail purchases. This development makes possible improved Household Expenditure surveys, as Statistics Iceland has demonstrated. Survey

respondents keeping a diary of their purchases need to record only the total of purchases when itemized receipts were given to them and keep these receipts in a special pocket in the diary. These receipts provide only a detailed breakdown of purchases but also the name of the outlet. Thus response burden is markedly reduced, accuracy is increased, product description is more specific and point of purchase data are obtained, facilitating the estimation of outlet-type weights. There are only two general principles for the estimation of weights: use all the available information and accept that rough estimates are better than no estimates.

Reweighting: Ideally, in computing an index, the weights would represent current annual expenditure patterns. In practice, they necessarily reflect past using the most recent data available or, if they are not of high quality, some average of the data for more than one previous year. Some countries have used a three-year average in recognition of the fact that household survey estimates are of poor quality. In some cases, some of the data sources used may not be available annually, in which case some of the weights for lower-level aggregates within higher-level aggregates are based on older data than the higher level weights. Infrequent reweighting saves costs for the national statistical office but delays the introduction into the index of new types of expenditure. For example, subscriptions for internet service entered index compilation with a considerable time lag in some countries, and account could be taken of digital camera prices between re-weightings only by including some digital cameras in the same elementary aggregate as film cameras.

Owner-occupiers and the price index: The way in which owner-occupied dwellings should be dealt with in a consumer price index has been, and remains, a subject of heated controversy in many countries. Various approaches have been considered, each with their advantages and disadvantages. These approaches include:

The economists' approach: Leaving aside the quality of public services, the environment, crime and so forth, and regarding the standard of living as a function of the level and composition of individuals' consumption, this standard depends upon the amount and range of goods and services they consume. These include the service provided by rented accommodation, which can readily be priced, and the similar services yielded by a flat or house owned by the consumer who occupies it. Its cost to a consumer is, according to the economic way of thinking, an 'opportunity cost', namely what he or she sacrifices by living in it. This cost, according to many economists, is what should form a component of a consumer price index. Opportunity cost can be looked at in two ways, since there are two alternatives to continuing to live in an owner-occupied dwelling. One –supposing that it is one year's cost that is to be considered –is to sell it, earn interest on the owner's capital released, and buy it back a year later, making an allowance for its physical depreciation. This can be called the 'alternative cost' approach. The other, the 'rental equivalent' approach, is to let it to someone else for the year, in which case the cost is the rent that could be obtained for it.

There are practical problems in implementing either of these economists' approaches. Thus, with the alternative cost approach, if house prices are rising fast the cost can be negative and then become sharply positive once house prices start to fall, so such an index would be very volatile. On the other hand, with the rental equivalent approach, there may be difficulty in estimating the movement of rental values of types of property that are not actually rented. If one or other of these measures of the consumption of the services of owner-occupied dwellings is included in consumption, then it must be included in income too, for income equals consumption plus saving. This means that if the movement of incomes is to be compared with the movement of the consumer price index, incomes must be expressed as money income plus this imaginary consumption value. That is logical, but it may not what users of the index want.

Although the argument has been expressed in connection with owner-occupied dwellings, the logic applies equally to all durable consumer goods and services. Furniture, carpets, and domestic appliances are not used up soon after purchase in the way that food is. Like dwellings, they yield a consumption service that can continue for years. Furthermore, since strict logic is to be adhered to, there are durable services as well that ought to be treated in the same way; the service consumers derive from appendectomies or crowned teeth continue for a long time. Since estimating values for these components of consumption has not been tackled, economic theorists are torn between their desire for intellectual consistency and their recognition that inclusion of the opportunity cost of the use of durables is impracticable.

Spending: Another approach is to concentrate on spending. Everyone agrees that repairs and maintenance expenditure of owner-occupied dwellings should be covered in a consumer price index, but the spending approach would include mortgage interest too. This turns out to be quite complicated, conceptually as well as in practice. To explain what is involved, consider a consumer price index computed with reference to 2009 for just one sole consumer who bought her house in 2006, financing half of this sum by raising a mortgage. The problem is to compare how much interest such a consumer would now be paying with the interest that was paid in 2009. Since the aim is to compare like with like, that requires an estimate of how much interest would be paid now in the year 2010 on a similar house bought and 50 percent mortgage-financed three years ago, in 2007. It does not require an estimate of how much that identical person is paying now on the actual house she bought in 2006, even though that is what personally concerns her now.

A consumer price index compares how much it would cost now to do exactly what consumers did in the reference-period with what it cost then. Application of the principle thus requires that the index for our one house owner should reflect the movement of the prices of houses like hers from 2006 to 2007 and the change in interest rates. If she took out a fixed-interest rate mortgage it is the change in interest rates from 2006 to 2007 that counts; if she took out a variable interest mortgage it is the change from 2009 to 2010 that counts. Thus her current index with 1999 as reference-period will stand at more than 100 if house prices or, in the case of a fixed-interest mortgage, interest rates rose between 2006 and 2007. The application of this principle in the

owner-occupied dwellings component of a consumer price index is known as the 'debt profile' method. It means that the current movement of the index will reflect past changes in dwelling prices and interest rates. Some people regard this as odd. Quite a few countries use the debt profile method, but in doing so most of them behave inconsistently.

Consistency would require that the index should also cover the interest on consumer credit instead of the whole price paid for the products bought on credit if it covers mortgage interest payments. Products bought on credit would then be treated in the same way as owner-occupied dwellings. Variants of the debt profile method are employed or have been proposed. One example is to include down payments as well as interest. Another is to correct nominal mortgage rates for changes in dwelling prices or for changes in the rest of the consumer price index to obtain a "real" rate of interest. Also, other methods may be used alongside the debt profile method. Thus several countries include a purely notional cost of depreciation as an additional index component, applying an arbitrarily estimated, or rather guessed. Depreciation rate to the value of the stock of owner-occupied dwellings. Finally, one country includes both mortgage interest and purchase prices in its index.

Transaction Prices: The third approach simply treats the acquisition of owner-occupied dwellings in the same way as acquisitions of other durable products are treated. This means:

- Taking account of the transaction prices agreed;
- Ignoring whether payments are delayed or are partly financed by borrowing;
- Leaving out second-hand transactions. Second-hand purchases correspond to sales by other consumers. Thus only new dwellings would be included.

Furthermore, expenditure on enlarging or reconstructing an owner-occupied dwelling would be covered, in addition to regular maintenance and repair. Two arguments of an almost theological character are advanced in connection with this transactions approach.

One argument is that purchases of new dwellings are treated as 'investment' in the system of national accounts, so should not enter a consumption price index. It is said that this is more than just a matter of terminological uniformity. For example, it may be thought to help understanding and facilitate economic analyses if what is included under the heading of 'consumption' is the same in the consumer price index and in the national income and expenditure accounts. Since these accounts include the equivalent rental value of owner-occupied dwellings, the equivalent rental approach would have to be applied in the consumer price index too. But the national accounts do not apply it to other durables, so the argument demands consistency in one respect but accepts its rejection in another. The other argument is that the prices of new dwellings should exclude that part reflecting the value of the land, since this is a not reproductive and permanent asset that cannot be said to be consumed. This would presumably mean deducting site value from the price of a dwelling, site value

presumably being defined as the price the site would fetch at auction if dwelling were not on it. How this is to be understood in the case of multiple dwellings remains unclear.

The merits of the different approaches are multidimensional, including feasibility, views on the way the index should and would move in particular circumstances, and theoretical properties of the index. Statisticians in a country lacking a good dwelling price index (which is required for all except the rental equivalent method) will go along with a proposal to use such an index only if they can obtain the necessary additional resources that will enable them to compile one. Even obtaining mortgage interest rate data can be a major task in country with a multitude of mortgage lenders and many types of mortgage. Dislike of the effect upon the behavior of the consumer price index arising from the adoption of some methods can be a powerful, if sometimes unprincipled, argument. Dwelling prices are volatile and so on, therefore, would be an index incorporating the current value of a dwelling price sub-index which, in some countries, would have a large weight for owner-occupied dwellings could be altered considerably when reweighting was undertaken. (It could even become negative under the alternative cost approach if weights were estimated for a year during which house prices had been rising steeply). Then, there is the point that a rise in interest rates designed to halt inflation could paradoxically make inflation appear higher if current interest rates showed up in the index. Economists' principles are not acceptable to all; nor is insistence upon consistency between the treatment of owner-occupied dwellings and other durables.

1.1 The early history of price index research

In order to limit the size of his paper, Jack Triplett has chosen to concentrate on the history of price measurement research during the last three decades. The purpose of this paper is to discuss his survey and augment it by presenting a brief overview of the ancient history of price measurement. Basically, Triplett takes the economic approach to index number theory as being the correct approach. He distinguishes three main variants of the economic approach:

(i) the cost of living index;

(ii) the output price index and

(iii) the input cost index.

Most of Triplett's review concentrates on three topics:

(i) the likely size of the substitution bias (which occurs when we use the Paasche or Laspeyres price indexes to approximate the underlying true economic index);

(ii) the appropriateness of using either a Divisia (1926) index or a Chain index and

(iii) the appropriate treatment of quality chanze in the construction-of price and quantity indexes, which is otherwise known as then & problem. The largest part of the Triplett paper is devoted to

the last topic. This part of the paper is extremely interesting in its own right and is also valuable from the viewpoint of the history of the subject since Triplett was not only an active researcher in hedonic quality adjustment techniques1, but he was also (and still is) a civil servant and thus was well positioned to comment on Statistical Agency reactions to new measurement techniques. The overall impression of the paper is quite favorable.

Jack Triplett is an empirically oriented economist who knows the underlying theoretical literature very well. He has presented us with a survey of lasting value. At this point, I would like to list some of his insights that I found particularly interesting or worthy of strong endorsement (points of disagreement will be discussed later):

(i) .With the exception of housing, consumer durables are treated as if they were entirely consumed within the year of purchase. This treatment is appropriate in the production accounts but it is not appropriate in the consumer accounts. Along with Triplett, I believe that statistical agencies should make available a rental price treatment of all major categories of consumer durables as supplementary information to their present series. A rental price treatment of purchases of new durable goods would also affect our measure of savings: a consumer's purchase of a durable should be decomposed into a user cost portion and a savings portion and the latter part should be added to conventional savings.

(ii). I am basically sympathetic to his treatment of the continuous time Divisia index. Triplett (1988, 32) points out that we have to approximate the continuous time index by a discrete time approximation. The problem is that there are many discrete approximations that are available but Divisia's theory gives us no guidance as to the specific functional form for the discrete approximation. I shall elaborate on this point in section 5 below:

(iii). I strongly endorse Triplett's (1988, 30-82) comments on the inadequacies of existing data on wages.

(iv). Finally, Triplett's (1988, 77) comments on the problems caused by inadequate documentation of official data series deserves to be stressed.

We conclude this section by presenting art outline of the remainder of this paper. At least five distinct approaches to price and quantity measurement (or index number theory) can be distinguished in the early literature on the subject:

(i) the tabular standard (or the commodity standard or the fixed basket approach);

(ii) the statistical approach;

(iii) the test approach;

(iv) the Divisia index approach and

(v) the economic approach.

We shall discuss the history of each approach in turn in sections 2-6 below. In sections 7 to 11 below, we shall discuss a number of issues that are raised by a reading of Triplett's paper -issues that are perhaps somewhat controversial. Section 7 briefly discusses the merits of the test approach to index number theory while section 8 presents an extended discussion of the chain principle. Sections 9 and 10 discuss the possible magnitudes of the substitution bias and the new good bias respectively while section 11 asks whether the theory of the cost of living index has been exhausted. Section 12 concludes with a list of recommendations directed towards Statistical Agencies.

A. The Fixed Basket Approach

The essence of the fixed basket approach or the tabular standard may be explained as follows. Suppose that there are N goods that consumers in a location can purchase during two periods. In periods 1 and 2, the relevant price vectors are $p^1 = p^1_1 , \dots , p^1_N)$ and $P^2 = (p^2_1 , \dots , p^2_1 , \dots , p^2_N)$ respectively. Suppose further (unrealistically) that the quantities purchased of the N goods are constant during the two periods, with the 4 constant vector of purchases being defined as $q = (q^1 , \dots , q_N)$. Then a natural measure of the average level of prices in period 2 relative to period 1 is p^2*q/p^1*q where $p^t*q = \sum^N_{n-1} p^t_n q_n$ is the inner product of the vectors P^t and q.

The above approach to price measurement has been independently proposed by many people. The earliest known proposer of the method was William Fleetwood, the Rishop of Ely, who wrote the book Chronicon Preciosum in l7O7. The constant basket of goods he used to compare the value of money (or conversely, the level of prices) for an Oxford student of 1707 compared to an Oxford student of 1460 was 5 quarters of wheat, 4 hogsheads of beer and 6 yards of cloth.

Perhaps the next independent discovery of the tabular standard was made by the Legislature of Massachusetts in 1780. An account of this discovery is given by Willard Fisher (1913). A tabular standard was used to index the pay of Soldiers fighting in the Revolutionary War (a massive inflation had drastically reduced the real value of the fixed nominal pay of the soldiers). The constant quantity basket was S bushels of corn, 68 and 4/7 pounds of beef, 10 pounds of sheep's wool and 16 pounds of sole 5 leather. Joseph Lowe (1823, 316) was not an independent discoverer of the constant basket index number formula) = $p^2 \bullet q/p^1 \bullet q$,

since he explicitly refers to Fleetwood's book. However, he developed the concept in such detail that he should be considered the father of the consumer price index. Lowe was well aware that the constant basket of 5 commodities q could vary across demographic groups; on page 332, he presented some representative family budgets for cottagers and for the middle class. On page 97 of the Appendix, he noted that price indexes may be required for other classes of consumers or producers such as farmers and miners while on page 336 of the main text, he advocated the construction of separate "standards" for the laboring class, decomposed. into unmarried laborers and married laborers dth 2,3, or 4 children. Finally, Lowe (1823,33) also envisaged a national "table of reference" which would price out a constant national consumption vector at the prices of each year t and on pages 94 and 95 of the Appendix, he constructed two such hypothetical tables.

How would the constant vector of commodities q in (1) be determined? Lowe (1823, Appendix 95) answered this question as follows:

"As to quantity, a variation can take place only with increase of population or change of habits, and any alteration of that kind must be so gradual, that we run very little hazard in assuming a similarity of amount during a given period, which for the sake of precision, we shall supposed to be five years."

Lowe (1823, 334) also proposed that the national government should fund the collection of the relevant price and quantity statistics, but if this was not done, the Lowe felt that government agencies should at least provide what data they had at their disposal "on the demand of any respectable association."

Lowe (1823, 335 - 343) listed a host of applications for his proposed tables of reference, including the following:

(i) wages, salaries and rents could be indexed to eliminate the anomalies arising out of unforeseen fluctuations in the value of the country's currency,

(ii) they would facilitate salary negotiations,

(iii) they could be used to index long term agricultural leases and

(iv) bond holders could be paid in real terms if they wanted that option.

Lowe (1823, 346) concluded with some pertinent observations on why his proposal had not been implemented up to his time:

"This has, we believe, been owing to two causes; the unfortunate neglect of political economy in the education of our public men; and the interest of government, the greatest of all debtors, to prevent the public from fixing its attention on the gradual depreciation of money that went on during the half century to the late peace".

Scrope (1833, 406-407) followed in Lowe's footsteps but was the first to use the term tabular standard to describe the price index defined by (1). However, his treatment was not nearly as detailed as that of Lowe6, so we will pass on to list others who have endorsed the tabular standard. If quantities were to remain constant during the two periods under consideration, a whole host of authors endorsed formula (1) to measure price change, including Jevons (1865,l22) (1.884,l22), Sidgwick (1883,67-68) Edgeworth (l925, 2l2) (originally published in 1887), Marshall (1887, 363), Rowley (1899)(1901, 227) (1928, 223), Walsh (1901, 540), (1921, 543) (1924,544) and Pigou (1912,38). During this period, the precise specification of the constant quantity vector q was a problem which was addressed. Thus Laspeyres (1871) proposed that q should equal $q^1 = (q^1_1 , \dots , q^1_N)$, the base period quantity vector, while Paasche (1874) proposed that q should equal

$q^2 = (q_1^2 , ... , q_N^2)$, the current period quantity vector. Thus (1) can be specialized to yield the famous Laspeyres and Paasche price indexes, p_l and p_p

(2) $P_L (p^1, p^2, q^1, q^2) = p^2 * q^1 / p^1 * q^1$;

(3) $P_p (p^1, p^2, q^1 , q^2) = p^2 \bullet q^2 / p^1 \bullet q^2$

Given that quantities would not be exactly equal during the two periods under consideration, various authors started to argue that averages of (2) and (3) should be used to measure price change. Thus Sidgwick (1883, 68) and Rowley (1901, 227) proposed the use of (1/2) P_L +(l/2) P_P. While Edgeworth (1925, 214) (originally published in 1887) proposed that the q in (1) be set equal to the arithmetic average of the two quantity vectors, (1/2) q^1 + (l/2) q^2, (Edgeworth states that this variant was also independently proposed by Alfred Marshall). Rowley (1899) suggested the geometric mean of P_L and P_P,, which later came to be known as Irving Fisher's (1922) ideal price index P_F defined as:

(4) $P_F (p^1, p^2, q^1, q^2) = [p^2 \bullet q^1 \, p^2 \bullet q^2 / p^1 \bullet q^1 \, p^1 \bullet q^2 \}^{1/2}$

Walsh (1901, 398) proposed that the components q. of the quantity vector q in (1) should be set equal to the geometric means of the quantities in the two periods. Thus the Walsh price index is

(5) $P_w (p^1, p^2 , q^1 , q^2) = \sum_{i=1}^N (q_i^1 q_i^2)^{1/2} p_i^2 / \sum_{j=1}^N (q_j^1 q_j^2)^{1/2} p_j^1$.

Finally, Pigou (1912, 46) suggested PLPPa5 a measure of price change. Since this price index has rather poor homogeneity properties, Pigou later 8 modified his measure by taking the square root which yields F defined by (4); see Pigou (1932, 69). At this stage, the fixed basket approach to index number theory merged into the test and economic approaches.

B. **The Statistical Approach**.

This approach, which originated with Jevons (1965) (1884), assumed that increases in the supply of money increased all prices proportionately except for random fluctuations. Thus with additive errors and a sufficient number of independent observations, an appropriate price index could be obtained by taking the arithmetic mean of the price ratios p/p while with multiplicative errors, an appropriate price index could be obtained by taking the geometric mean of the price ratios. This second alternative was advocated by Jevons, and thus we obtain the Jevons price index P_J:

(6) $P_J (P^1 , P^2) = n_{i=1}^N (p_i^2 / p_i^1)^{1/N}$.

In addition to Jevons, two other prominent economists who advocated the statistical approach to index numbers were Sowley (1901, 223 – 226) (1921, 202), (1928, 217 – 223) and Edgeworth (1888) (1896) (l90l) (l923) (1925) 8. Edgeworth mainly advocated the median of the price ratios p_i^2 / p_i^1 as the best estimator of price change.

The statistical approach was criticized by Irving Fisher (1911, 194 - 196) who explained in an absolutely convincing manner why all prices cannot move proportionately (due to the existence of fixed price contracts, for example. Fisher's criticisms were ignored by the profession as were those of Walsh (1924). However, Keynes (1930, 71 - 81) effectively demolished the naïve statistical approach by constructing various tables of index numbers which showed systematic differences over time and hence the hypothesis of approximate proportional change in all prices could not be maintained empirically. Bowley (1928; 221) also criticized the approach on narrower statistical grounds by indicating that the price movements were not statistically independent.

Although Jevons' naive statistical approach is no longer advocated, as was indicated in Triplett's (1988) paper, statistical sampling of the prices of the various components of a price index is still done today. A problem with many of these sampling procedures is that prices are sampled independently of quantities. Pigou (1932, 77) was perhaps the first to propose that values should be sampled in the two periods under consideration, along with the corresponding prices and quantities, and then the Fisher ideal index defined by (4) should be used to construct a measure of price change over the commodities in the sample of values. This sample price index could then be used to deflate the population value ratio over the two periods. Pigou's proposal deserves serious consideration by Statistical Agencies even today.

C. The Test Approach

The origins of the test approach are rooted in the more or less casual observation of the early workers in the index number field on their favorite index number formulae or those of their competitors. Thus Jevons (1884, 152) (originally published in 1865) recognized that his unweighted geometric mean formula (6) gave index number comparisons- between any two years that were independent of the base year. Edgeworth (1896, 137) gave a clear general treatment of this ka invariance Test J°10 which we can phrase as follows. Let $p(p^0,p^t\ q^0,q^t)$ be a generic index number formula of the type defined by (2) to (5) above which compares the level of prices in period t to the level of prices in period 0, the base year. Let p^t and q^t be the price and quantity vectors pertaining to year t for t = 0 , 1 , … , T . Let I, s and t denote arbitrary years. With the base year equal to 0, the level of prices in year t relative to s is taken to be:

$P (p^0 , p^t , q0 , q^t) / P (p^0 , p^s , q^0 , q^s)$.
If we change the base to year i, then the level of prices in period t relative to s is

$P (p^1 , p^t , q^1, q^t) / p (p^1, p^s, q^i, q^s)$, The base invariance test demands that these two numbers be equal; i.e., that

(7) $P (p^0 , p^t , q^0 , q^t) / P (p^0 , p^s , q^0 , q^s) = P (p^1, p^t , q^1 , q^t) / P (p^1 , p^s , q^1 , q^s)$.

Our next test was first proposed by Laspeyres (1871, 308), and has come to be known as the strong identity if prices in the two periods under consideration remain constant, then even if the quantities change11, the level of prices should remain unchanged; i.e., •we should have

(8) $p (p, p, q^1, q^2) = 1$

where P denotes the index number formula or function, $P = (p_1 , \dots , P_N)$ denotes the common price vector in both periods and $q^t = (q_1^t , \dots q_N^T)$ denotes the quantity vector in period t for t = 1, 2.

The statistician Westergaard (1853 – 1936) formulated what later became known as the circularity of the bilateral index number formula, it should satisfy the following equation:

(9) $P (p^1 , p^2 , q^1 , q^2) P (p^2 , p^3 , q^2 , q^3) = P (p^1, p^3 , q^1 , q^3)$

where P^t and q^t are the price and quantity vectors pertaining to periods t for t = 1, 2, 3.

The right hand side of (9) computes the price level in period 3 relative to the price level in period 1 in one step, using the bilateral index number formula or function P The left hand side of (9)
computes the level of prices in period 3 relative to period 1 in two steps: in the first step, we use the bilateral formula $p (p^1 ,p^2 ,q^1, q^2)$ to compute the level of prices in period 2 relative to period 1 and then in the second step, we use the bilateral formula $P (p^2,p^3,q^2 ,q^3)$ to compute the level of prices in period 3 relative to period 2. The product of these two steps is supposed to yield the level of prices in period 3 relative to period 1.

The Dutch economist Pierson (1896) informally proposed two tests: (i) invariance to changes in the units of measurement (which Irving Fisher (l911) (1922, 420) first called the change of units test and later called the commensurability test) and (ii) the time reversal test which can be stated mathematically as follows:

(10) $P (p^2 , p^1 , q^2 , q^1) = l/ P (p^1, p^2 , q^1 , q^2).$

Up to this point in time, research or the test or axiomatic approach to index number theory was rather casual and unsystematic. The first systematic researcher on the axiomatic approach was Walsh (l9Ol) (192l) (1924) who proposed a number of tests, including the constant Quantities i.e., if quantities remain fixed at the vector q during the two periods under consideration, then the appropriate formula for the price index is:

(11) $P (p^1 , p^2 , q, q) = p^2 .q / p^1 .q.$

Another test proposed by Walsh was the strong proportionality (in prices)i.e., if A is a positive scaler and prices in period 2 are equal to A times the corresponding prices in period 1, then

(12) $P (p^1, \lambda p^1, q^1, q^2) = \lambda.$

A final test proposed by Walsh (1901, 389) (l921, 540) (1924, 506) was his Multi-period identity test15 i.e., the bilateral index number function P is to satisfy the following functional equation;

(13) $P (p^1 , p^2 , q^1 , q^2) P (p^2, p^3 ,q^2 . q^3) P (p^3, p^1 , q^3 , q^1) = 1$

Note that the prices and quantities in period 4 are exactly equal to the prices and quantities in period 1, p1 and q1 respectively. As we shall see later, the test (13) will be useful in evaluating the usefulness of the chain principle. The next major contributor to the test approach is Irving Fisher (l911)(l921)(l922). Since Fisher's contributions to the test approach are quite well known (in fact, he is often credited with inventing the approach), we will not review his contributions in any detail. However, we do wish to make two comments about his work.

Our first comment is to note that Fisher (1911, 403) seems to have been the first to observe that the choice of a functional form P (p^1, p^2, q^1, q^2) for a price index implicitly determines the functional form for the corresponding quantity index Q (p^1, p^2, q^1, q^2); i.e., the product of the two indexes should equal the value ratio for the two periods under consideration. Thus given P, Q is implicitly determined by the following equation:

(14) $P (p^1, p^2 , q^1 , q^2) Q (p^1 , p^2 , q^1 , q^2) = p^2 .q^2 / p^1 .q^1$

Frisch (1930, 399) called (14) the product .at While Samuelson and Swarny (1974, 572)
called it the weak factor reversal test. Our second comment about Fisher's contributions to the test approach is relatively unknown. Fisher (1922, 140) explained how to 'rectify" an arbitrary bilateral index number formula p (p^1, p^2, q^1, q^2) so that the rectified formula p* would satisfy the time reversal test (10): simply
define p'* as follows:

(15) $P^* (p^1 , p^2 , q^1 , q^2) = p (p^1 , p^2 , q^1 , q^2) / P (p^2 , p^1 , q^2 .q^1)]^{1/2}$

Fisher's time rectification procedure indeed does work as advertised: the p*Defined by (15) will satisfy (10). The only problem is that the procedure is clearly due to Walsh (1921, 542), who was a discussant for Fisher's (1921) paper which was a preview for Fisher (1922).

Unfortunately, Fisher's (1922, 183) historical comments on the rectification principle fail to mention Walsh at all. However, on the positive side, Fisher (1922.396-398) generalized Walsh's basic idea by showing how an index number formula could also be rectified to satisfy Fisher's factor reversal fl.at16 or be rectified to simultaneously satisfy the factor and time reversal tests. Frisch (1930) (l936,5-7) effectively criticized the test approach to index number theory on the grounds that it could be shown that no bilateral index number formula P (p^1,p^2,q^1,q^2) could satisfy all reasonable tests or axioms17 and when some tests were dropped so as to achieve a consistent set14 of tests, there was no general agreement on which subset of tests should be dropped. Hence the test approach did not seem to lead anywhere. In recent years, the test approach has sprung to life again, largely due to the efforts of Wolfgang Eichhorn (l973) (1976) and his students and 18 colleagues.

D. The Divisia Approach.

Divisia's (1926, 39 – 40) derivation of the price and quantity indexes associated with his name can be summarized as follows. Let the prices $p_i(t)$ and the quantities q_i (t), i = l , …, N, be functions of (continuous) time t and let expenditure at time t be the value $v(t) = \sum_{i=1}^{N} p_i(t)q_i(t)$.

Assuming differentiability, the rate of change of value at time t is:

(16) $dv(t) / dt = \sum_{i=1}^{N} p_i (dq_i / dt) + \sum_{i=1}^{N} q_i (dp_i / dt)$.

Divisia then divided both sides of (16) by $p(t).q(t) = \sum_{i=1}^{N} p_i (t)q(t)$ and equated the right hand side of the resulting equation to $Q'(t) / Q(t) \div P'(t) / P(t)$ where Q(t) and P(t) are aggregate quantity and price levels pertaining to period t and Q'(t) and P'(t) denote their time derivatives.

Thus we have:

$$(17)\ \sum_{i=1}^{N} \frac{p_i q_i'(t)}{V(t)} + \sum_{i=1}^{N} \frac{q_1 p_1'(t)}{v(t)} = \frac{Q'(t)}{Q(t)} + \frac{p'(t)}{p(t)}$$

Divisia then defined Q(t) and P(t) as solutions to the following differential equations:

$$(18)\ \frac{Q'(t)}{Q(t)} = \sum_{i=1}^{N} \frac{p_i(t)\, q_1'(t)}{p(t).q(t)}\ ;\ \frac{P'(t)}{p(t)} = \sum_{i=1}^{N} \frac{q_1(t)\, p_i'(t)}{p(t).q(t)}$$

Somewhat surprisingly, virtually the same derivation was made earlier by the English economist, T.L. Rennet (1920, 461), except that he did not divide (16) through by v (t) —p (t)' q (t).

The above derivation of the Divisia indexes is very mechanical and is unrelated to economics (i.e., choice under constraint). However, later both yule (1946) and 1-lulten (1973) related the Divisia indexes to economic price and quantity indexes under the assumptions of optimizing behavior and a linearly homogenous aggregator function.'9

Triplett (1988) observes, the problem with the Divisia approach to price measurement is that we generally cannot observe prices and quantities continuously. Thus the continuous time Divisia indexes must be approximated using discrete time data and there are many ways of forming discrete time approximations to say $P(2)/P(1)$[20], where P(t) is the Divisia index for time period t defined by (18) (plus an initial normalization).

Diewert (1980,444-445) showed that the Laspeyres and Paasche indexes, and P, defined by (2) and (3) above, could be regarded as discrete time approximations to P(2) / P(l) as could the Tornqvist-translog T defined by

$$(19)\quad \text{in } P_T(p^1, p^2, q^1. q^2) = \sum_{i=1}^{N} (1/2)(s_i^1 + s_1^2) \ln (p_i^2 / p_i^1)$$

where the shares s_i^t are defined as $s_i^t = p_i^t q_i^t / p^t.q^t$, $t = 1, \ldots, N$.

Since the indexes P_L, P_P and P_T can differ considerably, the Divisia approach does not lead to a practical resolution of the price measurement 21 problem.

To conclude this section on the Zennet-Divisia approach, we note that Rennet (1920, 457) suggested the following discrete approximations to 16 measure differences (rather than the ratios of Divisia) in the aggregate price and quantity levels:

(20) $\Delta P = P(2) - P(1) = \sum_{i=1}^{N} (1/2)\,(q_1^1 + q_1^2)\,(p_1^2 + p_i^1)$;

(21) $\Delta Q = Q(2) - Q(1) = \sum_{i=1}^{N} (1/2)\,(p_1^1 + p_1^2)\,(q_1^2 + q_i^1)$

Bennet also showed that the difference in expenditures for the two periods,

$\sum_{i=1}^{N} p_i^2 q_i^2 = \sum_{i=1}^{N} p_i^1 q_i^1$, was exactly equal to $\Delta P + \Delta Q$, where ΔP and ΔQ are defined by the right hand sides of (20) and (2l).[22]

E. The Economic Approach.

The economic approach to index number theory23 relies on the assumption of optimizing behavior on the part of economic agents: utility maximizing or expenditure minimizing behavior on the part of consumers and profit maximizing or cost minimizing behavior on the part of producers. The first two papers to use an explicit utility maximizing framework appear to be by Bennet (1920) and Kon'üs (1924). Bennet's paper drew on an earlier paper by Bowley (1919) (he used Bowley's notation and data) and may be regarded as an attempt to determine the approximate magnitude of the substitution bias using the assumption of an quadratic utility function.

Bowley (1928, 226) (1938) was in turn influenced by Bennet and developed his own quadratic approximations. Bennet's paper was very short and sketchy and did not have the impact that the KonUs paper eventually had. KonUs (1924,16-18) not only presented a very clear definition of the true cost of living for an individual optimizing consumer, he also developed the now well known Paasche and Laspeyres bounds.24 Kodüs (1924, 20-21) also showed that the Paasche and Laspeyres price indexes, (3) and (2) above, bound the 17 true cost of living index even in the general nonhomothetic preferences case, provided that we evaluate the true index at a suitable utility level that is between the base and current period levels.

To complete our brief survey of the early history of the economic approach to index number theory, we shall review the economic approach under four subdivisions:

(i) basic theoretical definitions,

(ii) the theory of bounds,

(iii) exact index numbers and

(iv) econometric approaches.

E.1 Basic Theoretical Definitions

As Triplett (1988) noted, there are three main branches of price index theory.

(i) For the true cost of living index, see Kcrs (1924), Sarnuelson (1947, 156) and Pollak (1971). For related quantity indexes,, see Rowley (1928230), Allen (1949), Malmquist (1953) and Pollak (1971).

(ii) For theoretical definitions of the output price index, see Hicks (1940), Fisher and Shell (1972), Sainuelson and Swamy (1974; 588-592), Archibald (1977) and Diewert (198Th). For related quantity indexes, see Rowley (1921, 203), Bergson (1961, 31-34), Moorsteen (1961), Fisher and Shell (1972, 53), Sarnuelson and Sway (1974, 588-591), Sato (1976, 438) and Hicks (1981, 256).

(iii) The input cost index is defined by Triplett (1983a, 274) and Diewert (1980, 459) and corresponding quantity indexes are defined in Diewert (1980, 456-460).

There is a fourth branch of price index theory not mentioned by Triplett: (iv) constant utility income deflators. On this last branch of theoretical index number theory, see Diewert and Bossons (1987).

E.2 The Theory of Bounds

Observable bound to the generally unobservable economic price and quantity indexes were first worked out by Pigou (1912, 44 - 46)(l932, 62-63) and Haberler (1927,78 - 92) independently of Kontis (1924, 17 - 19) established the Paasche and Laspeyres bounds for the true cost of living. For a generalization of these bounds to nonlinear budget constraints, see Frisch (l936, l8).25 It is clear that a large portion of revealed preference theory that is often attributed to Hicks (1940) and Samuelson (1947, 157) had already been developed by Pigou, Kon'ds, Haberler and Frisch. Other researchers who established bounds on true indexes in the two observation situation include Leontief (1936,49), Friedman (1938, 125), Allen (1949), Malrnquist (1953), Moorsteen (1961, 464), Pollak (1971), Fisher and Shell (1972, 57 - 62), Samuelson and Swamy (1974, 581591), Archibald (1975) and Dietert (l9Sl , l57-l79) (1983a, 173 - 2lO)(l983b, l056 - lO9O). The above theory of bounds all pertains to the two observation situation. Afriat (1967) (1977) generalized the two observation theory to cover the many observation case.

E.3 Exact Index Numbers

Let an aggregator function[26] f(q) be given where q is an N dimensional quantity vector; i.e., $q = (q_1 , \dots , q_N)$, The cost function C which is generated by f may be defined as

(22) $C (u , p) = \min_q (p.q : f (q) \geq (u)$;

i.e., C (u, p) is the solution to the problem of minimizing the cost $p.q = \sum_{i=1}^{N} p_i q_i$ of achieving at least the utility (or output) level u, where p 19 an exogenous vector of prices facing the consumer (or producer). An index number formula or function $P(p^1,p^2,q^1,q^2)$ of the type we considered in section 4 is defined to be exact[27] for an aggregator function f if

(23) $P (p^1, p^2 ,q^1 ,q^2) = C (u,p^2) / C (u, p^1)$

for some utility or output level u where q^t solves (22) when p - p^t for t = l, 2; i.e. P
is exact for f (or its dual cost function C) if P equals the relevant economic index under the assumption of optimizing behavior on the part of an economic agent using the aggregator function f. The right hand side of (23) is P_k (p^1, p^2, u), the Konus price index or true cost of living index for a consumer that has the utility function f and faces the vector of prices P^t in period t for t = l, 2.

The English language literature on exact index numbers has its roots in the theory of quadratic approximations. As we indicated earlier, Rennet (1920, 460) attempted to determine an appropriate index number formula for the true cost of living of a single "satisfaction' maximizing consumer under the hypothesis that the underlying utility function f(q) was a general quadratic function. Rowley (1928, 226) (1938) followed up on Rennet's approach and provided his own second order approximation.

Frisch (1936, 27 - 29) criticized Rowley's index number formula and developed an alternative formula which he called the double expenditure method. Wald (1939, 329) and Balk (1981, 1556) correctly pointed out that Frisch's index number formula was exact for a general quadratic utility function. However, Frisch (1936, 29-30) did correctly show28 that his index number
20 formula collapsed to the Fisher ideal price index defined by (4) if one assumed hornothetic quadratic preferences so that:

f (q) = $\sum_{i=1}^{n} \sum_{j=1}^{N} a_{ij} q_i q_j$ = q.Aq where A = $\{a_{ij}\}$is a symmetric N by N matrix of parameters that characterize tastes. This is an early example of an exact index number formula.

Another early example was given by Raid (l939) (l939, 325) who Assumed the following general quadratic aggregator function:

(24) f (q) = a_0 + a.q + (l/2) q* , A-A^t ,

where a_0, a = [d_1 , … , d_N] and A= $\{a_{ij}\}$ are respectively a parameter, a vector of parameters and a symmetric N by N matrix of parameters.

Unfortunately, in order to evaluate Raid's general index number Formula that is exact for (24), information on income elasticities is required (we shall not write out his general index number formula since it is rather complex). However, if we assume hornothetic preferences again
(i.e., the aggregator function is a monotonically increasing function of a linearly homogeneous function) so that a_0 —0 and a — 0_N in (24)[29] then all of the consumer's income elasticities equal unity and Wald's general index number formula collapses down to the Fisher price index (4) and again we obtain the exact index number result of Frisch,3° Unknown to the above authors, the Frisch-wald exact index number result had already been obtained by KonUs and Byushgens (1926, 167-172) a decade earlier,31 In this remarkable paper, they introduced duality theory into the economics literature; i.e, they expressed consumer preferences notably by the direct utility function f(q) but also by the corresponding indirect utility function g defined as follows:

(25) g (p ,y) = $\max_q$ f (q) : p.q ≤ yl ;

i.e., the indirect utility function g (p, y) gives the maximum utility attainable as a function of the prices faced by the consumer $p = (p_1 , \dots , p_N)$ and the income or expenditure $y \geq 0$ to be spent on the N goods during the period under consideration. Kon'ds and By ushgens assumed that the direct utility function f was linearly homogeneous in which case the indirect utility function g can be expressed as follows in terms of the unit cost function:

c (p) = C (1 , p) where C (u , p) was defined by (22) above:

(26) g (p , y) —y / c (p).

Konlls and Byushgens considered three classes of homothetic preferences which were defined via the indirect utility function g(p ,y) or equivalently, using (26), via the unit cost function c(p).

The first case they considered had the following unit cost function:

(27) $c (p) = \sum_{I=1}^{N} a_i p_i , \quad a_i.>0, \quad i=1 , \dots , N.$

As is well known32, the dual direct utility function is the fixed coefficient or no substitution f defined as follows:

(28) $f (q_1 , \dots , q_N) = \min_i (q_i/a_i : i = 1 , \dots , N).$

Under these conditions, KonUs and Byushgens (1926,162) showed that the Laspeyres and Paasche indexes, P_L and P_P defined by (2) and (3) above, will - exactly equal the true cost of living (defined by the right hand side of (23) for any positive utility level u), provided that the consumer's direct utility function is defined by (26) and (27).

22 The second case they considered was the case of Cobb-Douglas Preferences[33] which can be characterized by the following unit cost function:

(29) $c (p) = \infty \pi_{I=1}^{N} P_i \infty_I \quad . \quad \infty_1>0 \quad , \quad \sum_{i=1}^{N} \infty i = 1 ,$

KonUs and Byushgens (1926,165) showed that the generalized Jevons index defined by (6) (except that 1/N is replaced by ∞_i.) is exact for these Wicksell-Cobb-Douglas preferences, where the unknown parameters ∞_i. can be determined as follows:

$\infty_1 = p_1^t q_i^t / p^t .q^t$, the ith expenditure share, i=1, … , N, for any period t.

In the final case considered by KonUs and Byushgens (1926, 168), the consumer's preferences were characterized by the following unit cost function:

(30) $c (p) = (P.BP)^{1/2} = (\sum_{I=1}^{N} \sum_{i=1}^{N} b_{ij} p_i p_j)^{1/2}$

where $B = [b_{ij}]$ is a symmetric N by N matrix of unknown parameters that characterize preferences. They showed that the Fisher ideal index P_F defined by (4) was exact for the

preferences characterized by (26) and (30). KonUs and Byushgens (1926, 171) also showed that if the inverse of the matrix B existed, say $A= B^{-1}$, then the direct utility function corresponding to (26) and (30) was:

(31) $f(q) = (q.Aq)^{1/2}$

which is a monotonic transformation of the homogeneous quadratic utility function considered by Frisch and Wald.

Finally, RonUs and Byushgens (1926, 171) exhibited both the system of inverse demand functions, p/y =Aq / q.Aq, and the system of ordinary demand functions, q —yBp / p.Bp, that correspond to the homogeneous quadratic preferences defined by (31). They also suggested that the unknown parameters appearing in the A or B matrices could be determined given a sufficient number of price and quantity observations. However, note that a knowledge of A or B is !32t required in order to evaluate the Fisher price index P_F.

After the contributions of Bowley, Frisch and Wald to the theory of exact index numbers, the subject remained dormant until Afriat (1972, 44 - 47), Pollak (1971, 117 - 132) and Samuelson and Swamy (1974, 573 - 574) reexamined the subject. All of these authors examined the three cases considered by Konus and Byushgens and some other cases as well.

Diewert (1976, 134) defined a price index function $P(p^1, p^2 , q^1 , q^2)$ to be superlative if P was exact for preferences which had a cost function C (u ,p) = u c (p) where c (p) is a unit cost function that could provide a second order approximation to an arbitrary twice continuously differentiable linearly homogeneous function. The idea was that a superlative index number formula $P(p^1 p^2,q^1,q^2)$, which could be evaluated using only observable price and quantity data for the two periods under consideration, would correspond to a flexible functional form for a unit cost function c (p). For example, P_F defined by (4) is a superlative price index since it is exact for the c defined by (30) and this c has the required second order approximation property. Another example of a superlative index is the Walsh index P_W defined by (5) since it is exact for the unit cost function which is dual to the aggregator function.

$F(q) = \sum_{i=1}^{N} \sum_{j=1}^{N} a_{ij} q_i^{1/2} q_j^{1/2}$; see Diewert (1976, 132). A third example of a superlative price index is 'T defined by (19) which is exact for a translog unit cost function; 34 see Diewert (1976, 121).

Unfortunately, Diewert (1976) defined two (infinite) families of superlative index number formulae and this raised the question as to which formula should be used in empirical applications. Fortunately, Diewert (1978) showed that all choices of a superlative formulae gave the same answer to the second order and hence the choice was usually immaterial. More precisely, Diewert showed that every known superlative index number formula $P(p^1, p^2, q^1 , q^2)$ had the same first and second derivatives when evaluated at equal prices (i.e., $p^1 = p^2$) and equal quantities (i.e., $q^1 = q^2$)[35].

As an interesting footnote to the history of economic thought, it should be noted that Diewert was not the first to use the above second order approximation technique; Edgeworth (1901, 410-

411) used a variant of it to show that the Walsh index defined by (5) approximated to the second order the Edgeworth (1925, 213) –Marshall (1887, 372) index defined as follows:

(32) $P_{EM}(p^1, p^2, q^1, q^2) = \{ \sum_{i=1}^{N} (l/2)(q_i^1 + q_i^2) p_i^2) / [\sum_{j=1}^{N} (l/2)(q_j^1 + q_j^2) p_J^2]$.

The Taylor series expansion technique around an equal price and quantity point was used again by Edgeworth (1923, 347) to show that the Laspeyres index P_L defined by (2) and the Fisher index P_F defined by (4) satisfy the circularity test (9) to the first order. Since this Proposition seems to have been forgotten, we sketch a proof of it.

Let the index number function P be either P_L or P_F and define the functions f and g as follows:

(33) $f(p^1, p^2, p^3, q^1, q^2, q^3) = P(p^1, p^2, q^1, q^2) P(p^2, p^3, q^2, q^3)$;

$G(p^1, p^2, p^3, q^1, q^2, q^3) = P(p^1, p^3, q^1, q^3)$.

For $P = P_L$ or for $P = P_F$, it can be verified that the following equalities hold:

(34) $f(p^1, p^2, p^3, q^1, q^2, q^3) = g(p^1.p^2, p^3, q^1, q^2, q^3) = 1$;

$Vp^1 f(p^1, p^2, p^3, q^1, q^2, q^3) = Vp^1 g(p^1, p^2, p^3, q^1, q^2, q^3) = -q / p.q$;

$Vp^2 f(p^1, p^2, p^3, q^1, q^2, q^3) = Vp^2 g(p^1, p^2, p^3 .q^1, q^2, q^3) = 0_N$;

$V P^3 f(p^1, p^2, p^3, q^1, q^2, q^3) = V P^3 g(p^1, p^2, p^3, q^1, q^2, q^3) = q / p.q$;

$V_i f(p^1, p^2, p^3, q^1, q^2, q^3) = V_i g(p^1, p^2, p^3, q^1, q^2, q^3) = O_N \quad i = l, 2, 3$

provided that the above functions are evaluated at equal prices (i.e., $p^1 = p^2 = p^3 = p$) and equal quantities (i.e., $q^1 = q^2 = q^3 = q$) where $vp^i f = [df / dp_1^f, \ldots df / dp_N^f]$ is the vector of first order partial derivatives of £ with respect to the components of p^i, etc. The meaning of (34) is that the functions f and g approximate each other to the first order when evaluated at an equal price and quantity point. Thus the Laspeyres and Fisher price indexes satisfy the circularity test to the first order. Using the results in Diewert (1978, 898) and the results in the above paragraph, it can be shown that the Paasche, Laspeyres and all superlative 26 index number formulae will similarly satisfy the circularity test to the first order. Note that Edgeworth's Proposition helps to explain Fisher's (1922, 280) empirical finding that P_F satisfied the circularity test to a very high degree of approximation.

E.4 Econometric Estimation of Preferences

In this variant of the economic approach to index numbers, the Parameters that characterize consumer preferences are estimated. Preferences may be represented by:

(i) the direct utility function;

(ii) the indirect utility function;

(iii) the distance function or

(iv) the cost or expenditure function.

Once any one of these functions in known, the other three functions can be calculated, at least in principle. In particular, the cost function C (u , p) can be calculated and hence the Konlis price index defined by the right hand side of (23) can be calculated.

Triplett (1988) gives an excellent summary of most of the post 1948 research in this area; additional references to the recent literature can be found in chapter 7 of Deaton and Muellbauer (1980).It seems appropriate to add a few references to the early history of this approach to index number theory. The earliest effort at a strategy for determining the parameters which characterize preferences was made by Bennec (1920, 462). He assumed a quadratic direct utility function and showed how the consumer's system of demand functions could be obtained in the three good case (although he did not quite exhibit a closed form solution). He then made some comments on how many observations would be required in the general N good case in order to determine all 1 +N+(l/2)N(N+l) of the parameters of the quadratic 37 utility function f(q) defined by (24).

We have already seen that Konus and Byushgens (1926) were contributors to the econometric approach, since they derived the demand functions corresponding to Cobb-Douglas preferences and homogeneous quadratic preferences. Konus and Byushgens (1926,172) noted that one price-quantity observation would suffice to determine the parameters of Cobb-Douglas preferences while (N+l) / 2 observations would be required to determine all N (N+l) / 2 parameters for the homogeneous quadratic functional forms, (30) or (31). They also noted that statistical determination of the homogeneous quadratic preferences would be difficult.

Another early contributor to the econometric approach to index numbers was Wald (1937) (l939, 325), who assumed quadratic preferences; recall (24). In addition he assumed that the demand functions regarded as functions of income (or expenditure) were known functions for the two periods under consideration. (Alternatively, just a knowledge of the income elasticities of demand at the two observed price and quantity points would suffice).With these assumptions, Wald was able to derive an exact index number formula, so his approach is actually a blend of the exact and econometric approaches.

Wald's blended approach seems worthy of further study. However, the Pxg econometric approach has severe limitations. The problem with the latter approach is that in order to provide a second order approximation to general preferences, we require approximately 142/2 parameters

in the N good case. Since N is perhaps equal to 50,000 for a typical consumer (a supermarket alone has 15,000 to 20,000 separate items), the required number of parameters to be estimated is approximately 1.25 billion, which would require price and quantity observations for about 25,000periods.

This concludes our survey of the ancient history of index numbers. We turn now to a discussion of some of the more controversial issues raised by Triplett.

F. On the Test Approach to Index Number Theory

Triplett (1988) does not discuss the test approach to index number theory and perhaps the reader may well feel that this is quite appropriate due to the length of his paper. Although I am basically in agreement with Triplett that the economic approach to index number theory is the most compelling approach, it should be mentioned that the test approach has some advantages. In particular, the test approach does not suffer from the following limitations of the economic approach:

(i) the economic approach is based on optimizing behavior an assumption which may not be warranted in general;
(ii) the economic approach generally relies on separability assumptions39 about the underlying aggregator functions, assumptions which are unlikely to be true in general and
(iii) in deriving capital rental prices, the economic approach is usually based on an ex ante expectations about future prices, expectations which cannot be observed, whereas the test approach can be based on ex post accounting data, which can be observed

G. On the Chain Principle and Multilateral Indexes.

Triplett (1988) contrasts the chain principle with the fixed principle for constructing a series of index numbers which extends over three or more periods. Given price and quantity data, P^i, q^i , i=1,2,3 for three periods and a bilateral price index function $P(p^1,p^2,q^1,q^2)$ that depends only on the data for two periods, the fixed base sequence of aggregate price levels for the 3 periods would be:

(35) $1, P (p^1, p^2 , q^1 , q^2), P (p^1 , p^3 .q^1 , q^3)$

while the chain sequence of price levels would be:

(36) $1, P (p^1 , p^2 , q^1 , q^2), P (p^1 , p^2 , q^1 , q^2) P (p^2 , p^3 , q^2 , q^3)$.

Historically, the fixed base principle was the first to be used empirically. In the English language literature, the chain principle was first proposed by Alfred Marshall (1887, 373)41. Basically as a method for overcoming the difficulties in comparing prices over two distant periods, due to the invention of new commodities. Irving Fisher (1911, 203), who gave the chain system its name,

noted that the chain system was invariant to changes in the base period and he also saw the advantage of the method in dealing with the new good problem as the following quotation indicates:

"It may be said that the cardinal virtue of the successive base or chain system is the facility it affords for the introduction of new commodities, the dropping out of obsolete commodities, and the continued readjustment of the system of weighting to new commodities." (Fisher, 1911, 204). While it is true that the use of the chain principle has an advantage in dealing with the introduction of new commodities, it has the following severe disadvantage noted by Triplett (1988): it does not satisfy Walsh's Multiperiod Identity Test, (13) above.44 Thus as Triplett shows, if prices and quantities systematically oscillate around constant values, the use of the chain method will give biased results. This same point has been made by Szulc (1983) and Hill (1988).

The above difficulty with the chain method was not adequately appreciated by Diewert (1978,895) who argued for the use of the chain principle on the grounds that it would reduce the spread between the Laspeyres and Paasche indexes, (2) and (3) above, and between all known superlative indexes, since price and quantity changes will generally be smaller between adjacent periods than between distant periods. He argued that the spread between the Paasche and Laspeyres indexes would be greater than between the superlative indexes because P_L and P_P only approximate each other to the first order, while superlative indexes approximate each other to the second order (recall our discussion of the Edgeworth second order approximation technique in section 6.3 above). Diewert (1978,894) also presented the results of some numerical experiments using Canadian per capita consumption data for 13 commodity classes over the years 1947-1971. These results showed that the chain method did in fact lead to a smaller spread between P_L defined by (2). P_L defined by (2), P_P define by 3, P_F defined by (4) and P_T defined by (19) than when a fixed base year, 1947, was used.

Although the chain method will give poor results with oscillating data, Szulc (1983) and Hill (1988) show theoretically that chaining will tend to reduce the spread between the Laspeyres and Paasche price indexes, provided that prices and quantities trend monotonically over the time periods in question. Thus Diewert's (1978, 894) empirical results could be rationalized by the hypothesis that monotonic trends in the data outweighed oscillatory movements. While the chain system fails to satisfy Walsh's Identity Test (13), Hill (1988) showed that the fixed base system fails to satisfy an analogue to the Strong Identity Test (8). Consider the base period to be period 0 and suppose that the bilateral price and quantity indexes, P and Q respectively, are given and they satisfy the Product Test (14). Then under the fixed base system, price P* and quantity Q* comparisons between periods t and t+l are made as follows:

$$(37) \quad P^*(p^0, p^t, p^{t+1}, q^0, q^t, q^{t=1}) = P(p^0, p^{t+1}, q^0, q^{t+1}) / P(p^0, p^t, q^0, q^t);$$

$$(38) \quad Q^*(p^0, p^t, p^{t+1}, q^0, q^t, qt+1) = Q(p^0, p^{t+1}, q^0, q^{t+1}) / Q(p^0, p^t, q^0, q^t)$$

The problem is that P* and Q* need not satisfy counterparts of (8) even if the underlying bilateral indexes P and Q do satisfy (8); i.e., it will not generally be the case that

(39) $P^*(p^0, p^t, p^{t+1}, q^0, q^t, q^{t+1}) = 1$ if $p^t = p^{t+1}$

Hill (1988 , 6-7) cited the fixed base Paasche quantity index,

$Q(p^0, p^t, q^0, q^t = p^0 \cdot q^t / p^0 \cdot q^0)$, normally used in the national accounts, as an example of a fixed base index which generates a P* which fails to satisfy the Hill Identity Test (39)Thus both the chain and the fixed base systems fail to satisfy theoretically appropriate identity tests. We turn now to a discussion of possible alternatives to the use to either the fixed base or chain systems.

The first person to propose alternatives was Walsh (1901, 431), but it is convenient to start our discussion by reviewing some proposals due to Irving Fisher (1922, 297 - 320). Fisher's (1922, 298) first alternative was to list each and every possible binary comparison and thus the index number user could simply pick out the binary comparisons of interest. Let us (unimaginatively) call this the all binary comparisons method. Fisher actually implemented this method for his data on 36 primary commodities for 6 years using the Fisher ideal price index P_F defined by (4). Thus there were 6 (6—1) —30 bilateral comparisons. Fisher (1922, 301) then used these bilateral comparisons to determine whether the Base Invariance Test (7) was satisfied to a high degree of approximation:46 in Fisher's (1922, 302) words, "the differences due to differences of base are trifling."

However, Fisher (1922, 299 - 305) recognized that it was not practical or worthwhile to list every possible binary comparison: for twenty periods, there would be 380 separate index numbers. Thus Fisher was led to other classes of alternatives to the use of either the fixed base or the chain systems, which we will call multiperiod systems, or in the context of regional comparisons, multilateral systems. If there are data for T periods, these multilateral methods make use of the data for all T periods simultaneously to construct a series of T price levels and T quantity levels. Fisher's (1922, 305) first multiperiod or multilateral method was the blend system, which works as follows. Suppose we have price and quantity data, $P^t = (P_1^t, \ldots P_N^T)$) and $q^t = (q_1^t, \ldots q_N^t)$ for t—l, 2, …T and a bilateral index number formula $P(p^1, p^2, q^1, q^2)$. Then use each period as the base to construct a series of T aggregate price levels using the bilateral function P. Normalize the resulting series so that the first price is unity[47]. The resulting T series or normalized price levels may be written as follows:

(40) $1, P(p^1, p^2, q^1, q^2) / P(p^1, p^1, q^1, q^1), \ldots, P(p^1, p^T . q^1, q^T) / P(p^1, p^1, q^1, q^1);$

$1, P(p^2, p^2, q^2, q^2) / P(p^2, p^1, q^2, q^1), \ldots, P(p^2, p^T, q^2, q^T) / P(p^2, p^1, q^2, q^1);$

.

.

.

$I, P(p^T, p^2, q^T, q^2) / P(p^T, p^1, q^T, q^1)\ P(p^T, p^T, q^T . q^T) / P(p^T, p^1, q^T, q^1).$

Fisher then suggested that the price level for period t, P^t say, should be an arithmetic average of the period t price level in each of the T series in (40); i.e., we have P^1—1 and for t —2,3, …T

(41) $P^t = (l/T)\sum^T_{k-1} P (P^{K,}, p^t, q^k, q^t) / p (p^k, p^1, q^K, q^1)$.

Note that the multiteriod or multilateral period t aggregate price level defined by (41) is a function of the data for all T periods; i.e., p^t—p^t (p^1, …, p^T, q^1, …,q^T).The corresponding multiteriod or multilateral period t aggregate quantity level q^t may be defined as:

42 $Q^t (p^1, … p^T , q^1,… , q^T) = p^t . q^t / p^t (p^1 , …p^T ,q^1 , …, q^T)$.

Fishers (1922. 307) second multilateral method was the broadened base system. In this method, the period t price level p^t was defined as follows:

(43) $P^t (p^1 , …,p^T , q^1 ,…q^T) = (1 / T) (\sum^T_{k-1} q^k) . p^t , t = 1 , … , T.$

The corresponding quantity levels Qt can be defined numerically using the multilateral product test relations (42). This method was used by the Economic Commission for Latin America in the early 1960's. It is described in Ruggles (1967, 185) and is referred to as the market basket method. Note that (43) is a T period generalization of the two period Edgeworth-
Marshall bilateral formula, P, defined by (32) above. Fisher was not the first to suggest the market basket method: Walsh (1901, 431) suggested the same method but called it ScroDe's method ith arithmetic weights. Walsh (1901, 399) also suggested the following system of multilateral price levels pt which he called Scroe's method geometric weights:

(44) $P^t = \sum^N_{i=1} (\pi^T_{k-1} q_i^k)^{1/T} p_i^t , t = 1, … , T.$

The corresponding Qt can be defined by (42) as usual. It is obvious that (44) is the multilateral generalization of Walsh's bilateral index defined by (5) above. The above multilateral methods construct price and quantity levels for each period. It is also possible to devise multilateral methods where the multilateral price index gives the level of prices in period t relative to the level of prices in period s and is a function of all of the price
and quantity information for the T periods; i.e.,

$P^{st} (p^1 , …, p^T , q^1 , … , q^T)$. Thus Walsh (1924, 509) defined the following multiperiod generalization of the Fisher ideal index (4):

(45) $p^{st} = \{ p^t .q^1p^t.q^2 …p^t.q^T / p^s.q^1p^s.q^2 … p^s.q^T\}^{1/T} , s, t = 1 , … T.$

The corresponding quantity indexes can be defined as follows:

(46) $Q^{st} (p^1 , …,p^T ,q^1 , ...,q^T) = p^t .q^t / p^s .q^s P^{st} (p^1 , … , p^T,q^1 , … , q^T)$.

Gini (1931,10) also defined the multilateral price indexes ((45) and called the method the successive weights system. Both Walsh and Gini noted that (45) collapsed to defined by (4) if T = 2 and s = 1 and t = 2. Finally, Gini (1931, 12) did propose a new multilateral method which he

called the circular weight system, because the resulting system of price indexes p^{st} satisfied a multilateral analogue to the circular test (9)[48]. Given any bilateral price index function P (p^1, p^2, q^1 , q^2), define Gini's multilateral level of prices in period t relative to the period s level as follows:

$$(47)\ P^{st} = \{\frac{p(p^1, p^t, q^1, q^t)}{P(p^1, p^s, q^1, q^s)} \frac{p(p^2, p^t, q^2, q^t)}{p(p^2, p^s, q^2, q^s)} \cdots \frac{p(p^t, p^t, q^T, Q^t)}{p(p^T, p^s, q^T, q^s)}\}^{1/T}$$

For s , t=1, … , T. The corresponding Q^{st} can be defined by (46). This method was later proposed (using p_F as the P) by E1tet and K6ves (1964) and Szulc (1954) in the multiregional context and is known as the EKS system. Gini (1931,13-24) tested out his circular weight system (as well as some other alternatives) using the Fisher ideal 2F defined by (4) as his bilateral ?,for 8 time period observations on 5 Italian cities. Thus Gini's computations were both multiperiod (between time periods) and multilateral (between locations). The ratio type price indexes, (45) proposed by Walsh and (47) propose' by Gini, can be converted into price levels p^t (p^1 , … , p^T ,q^1 , … , q^T) as follows: corresponding to (45), define the period t price level p^t as:

$$(48)\ P^t = [\, p^t .q^1 \;\; p^t .q^2 \ldots p^t .q^T]^{1/T}, \quad t\text{-}1 , \ldots . , T$$

and corresponding to (47), define p^t as

$$(49)\quad P^t = [\, P(p^1 , p^t , q^1 , q^t)\, P(p^2 , p^t , q^2 , q^t)..P(p^T , p^t , q^T , q^t)]^{1/T}$$

In each case, it can be verified that $p^{st} = p^t / p^s$.

If we take the Gini-EKS price levels defined by (49) and divide each of them through by P1, it can be seen that the resulting normalized price levels p^t/p^1 are closely related to Fisher's (normalized) blended price levels defined by (41): for the Fisher price levels, we take the arithmetic means of the numbers. P (p^k ,p^t ,q^k ,q^t)/ P (p^k ,p^1 ,q^k ,q^1), k=l,..., T, while for the Gini-EKS price levels, we take the geometric mean of the same T numbers.

Walsh (190l, 399) (l924, 509) noted the primary disadvantage of using thet 1 TiT
muitiperiod full information price level functions $P^t(p^1, \ldots , p^T , q^1 , \ldots q^T)$:
if the number of periods increases, all of the indexes have to be recomputed. This is not necessarily a fatal objection since it is normal practice for statistical agencies to periodically issue historical revisions and there is no reason why the revisions could not be
accomplished using multiperiod indexes. However, at present, it does not seem prudent to enthusiastically endorse a multiperiod system of index numbers since not enough research has been done on the axiomatic properties of the various multilateral or multiperiod alternatives)0 Moreover, it would be desirable to develop multiperiod exact and superlative index number formulae and then examine the axiomatic properties of the resulting indexes. In the bilateral case, the Fisher ideal price index P_F emerges as the natural choice of a functional form since it seems to satisfy more reasonable tests than any other known formula and it is superlative as well. We need a multilateral counterpart to this "ideal" bilateral functional form.

To sum up: a comparison of the fixed base, chain, all binary comparisons and multiperiod systems leads to no clear choice at this stage. However, if a definite choice has to be made, I would vote for the chain system used with the bilateral Fisher ideal index P_F.

H. Is the Substitution Bias Small?

The substitution bias in the consumer price index is the discrepancy between the Laspeyres or Paasche price indexes, P_L and P_P defined by (2) and (3) above, and the consumer's true cost of living index, defined by the right hand side of (23). There is an analogous substitution bias in the output price index. The following quotation indicates Triplett's judgment on the size of the substitution bias: "Though it has long been a staple of economists' educations, the substitution bias in a fixed-weight price index for consumption is just not very large." (Triplett, 1988, 26).

To support the above opinion, Triplett cites the relatively close agreement between the Laspeyres and Paasche price indexes for U.S. aggregate consumption data. Triplett's judgment would be correct if in fact these indexes were true microeconomic Paasche and Laspeyres indexes, but they are not: microeconomic samples of price ratios P_1^{t+1} / P_i^t for various goods i are combined with base period expenditure shares that are obtained from periodic consumer expenditure surveys. The resulting aggregate indexes are not quite P_L and P_P defined by (2) and (3) above.

It may well be that Triplett is correct in his judgment, but the evidence to support his position has not yet been presented. Due to the computer revolution, it is now possible to undertake some experiments which could help to determine the extent of the substitution bias. Retail outlets that have computerized price and quantity information on their sales could be sampled. Detailed microeconomic price and quantity vectors p^t and q^t could be constructed and the Laspeyres, Paasche and Fisher indexes defined by (2) - (4) above could be calculated and compared with corresponding official consumer or producer price indexes that covered the same range of goods. Such firm oriented experiments could provide useful ui information on the size of the substitution bias.

I. Is the New Good Bias Small?

Triplett (1988) has a nice discussion of recent methods for adjusting for quality change that have been used by d Bureau of Labor Statistics. In keeping with the historical nature of this extended comment on Triplett, we shall first briefly review the ancient literature on methods for quality adjustment. Some of the early researchers on price measurement were aware of the problem of quality change but the pace and direction of the change did not seem large enough to warrant an explicit treatment.

However, by the latter part of the nineteenth century, Sidgwick (1883, 68) realized that not only were improvements in the quality of goods-leading to a bias in price comparisons, but also the growth of international and interregional trade (due primarily to transportation improvements) led to the systematic introduction of "entirely new kinds of things" and this too led to a bias in price comparisons. As the following quotation indicates, Sidgwick (1883, 68) thought that utility theory would play a role in eliminating these biases:

"Here again there seems to be no means of attaining more than a rough and approximate solution of the problem proposed; and to reach even this we have to abandon the prima facie exact method of comparing prices, and to substitute the essentially looser procedure of comparing amounts of utility or satisfaction." Unfortunately, the mathematical apparatus of consumer theory was not sufficiently developed at that time to enable Sidgwick to make any specific progress on the new good problem.

In a brilliant paper, Marshall (1887, 373) not only proposed the tabular standard, the chain system and the Edgeworth-Marshall index number formula (32), he also made the first real progress on the appropriate treatment of new goods, as the following quotation indicates:
"This brings us to consider the great problem of how to modify our unit so as to allow for the invention of new commodities. The difficulty is insuperable, we compare two distant periods without access to the detailed statistics of intermediate times, but it can be got over fairly well by systematic statistics. A new commodity almost always appears at first at something like a scarcity price, and its gradual fall in price can be made to enter year by year into re-adjustments of the unit of purchasing power, and to represent fairly well the increased power of satisfying our wants which we derive from the new commodity." (Marshall, 1887, 373).

As the above quotation indicates, Marshall was well aware of the product cycle and he felt that the early introduction of new commodities into the consumer price index in the context of the chain system would capture most of the benefits due to the introduction of new commodities. As we shall see later, not quite jj of the benefits are captured using Marshall's suggested method, since his method incorrectly ignores the new good in the first period that it makes its appearance.

Marshall (i .373, 374) also realized that improvements in transportation led to the general availability of location specific goods, such as fish at the seaside or strawberries at a farm. Marshall correctly felt that these "old" goods that suddenly became available at many locations should be regarded as "new' goods and treated in the same way as a genuinely new good. His words on this important observation are worth quoting:
"This class of consideration is of much more importance than at first sight appears; for a great part of modern agriculture and transport industries are devoted to increasing the periods of time during which different kinds of food are available. Neglect of this has, in my opinion, obviated the statistics of the purchasing power of many in medieval times with regard to nearly all kinds of foods except corn; even the well-to-do would hardly get so simple a thing as fresh meat in winter." (Marshall, 1887, 374).

Marshall's suggested treatment of the new good problem was acknowledged and adopted by many authors including Irving Fisher (1911, 204) and Pigou (1912, 47). As we saw earlier in section 8, Divisia (1926, 45) working from his independent perspective also suggested the use of the chain method as a means of dealing with the new good problem.

The next important contributor to the discussion of new goods in price measurement was Keynes. Keynes (1930,94) described in some detail one of the most common methods for dealing with the new good problem: simply ignore any new or disappearing goods in the two time periods under consideration and calculate the price index on the basis of the goods that

are common to the two situations. The corresponding quantity index was to be obtained residually by deflating the relevant value ratio by this narrowly based price index. Keynes called this method the highest common factor method. This method would be identical to Marshall's chain method if the two time periods were chosen to be adjacent ones. However Keynes (1930, 105 - 106) advocated his method in the context of a fixed base system of index numbers and he specifically rejected the chain method for 3 reasons:

(i) each time a new product is introduced, a chain index does not take into account the benefits of the expanded choice set, and thus over long periods of time, the chain price index will be biased upwards and the corresponding quantity index will be biased downwards;

(ii) the chain index fails Walsh's multi period identity test, (13) above, and

(iii) the chain method was statistically laborious.

Keynes' last objection to the chain method is no longer relevant in this age of computers. Moreover, Keynes was unable to offer any positive alternative to the chain method for comparing situations separated by long periods of time as the following quotation indicates: "We cannot hope to find a ratio of equivalent substitution For gladiators against cinemas, or for the conveniences of being able to buy motor cars against the conveniences of being able to buy slaves." (Keynes, 1930, 96).

However Keynes' first objection to the chain method (which was later echoed by Pigou (l932, 72)) was certainly valid (as was his second objection). A satisfactory theoretical solution to Keynes' first objection did not occur until Hicks adapted the analytical apparatus of consumer theory to the problem. When new consumer goods make their appearance for the first time, say in period 2, their prices and quantities can be observed. In period 1, the quantities of the new goods are all obviously zero but what are the corresponding prices? Hicks (1940, 114) provided a theoretical solution:

"They are those prices which, in the 1 situation, would just make the demands for these commodities (from the whole community) equal to zero. These prices cannot be estimated, but we can observe that between the two situations the demands for these commodities will have increased from zero to certain positive quantities; and hence it is reasonable to suppose that the 'prices' of these commodities will usually have fallen relatively to other prices. This principle is sufficient to give us a fairly good way of dealing with the case of new goods."

Of course, in the context of the producer price index, the appropriate period I shadow prices for the new goods are those prices which just induce each period 2 producer of the new goods to produce zero quantities in period 1. Hicks' basic idea was used extensively by Hofsten (1952, 95-97) who dealt not only with new goods, but also adapted the Hicksjan methodology to deal with disappearing goods as well. Hofsten (1952, 47-50) also presents a nice discussion of various methods that have been used to adjust for quality change, similar to Triplett's (1988) discussion of quality change measurement techniques.

Frank Fisher and Karl Shell (1972, 22 - 26) laid out the formal algebra for constructing the period 1 Hicksian "demand reservation prices" defined in the above quotation by Hicks. Diewert (1980, 498 — 501) used the Hicksian framework to look at the bias in the Fisher price index F defined by (4) when the reservation prices were incorrectly set equal to zero and compared this index to the Fisher price index that simply ignored the existence of the new goods in the two periods under consideration (which is Marshall's method). Diewert (1980, 501 - 503) also made some suggestions for estimating the appropriate Hicksian reservation prices in an econometric framework.

Is the new good bias large or small? One can only answer this question in the context of the price measurement procedures used by individual statistical agencies. In Diewert (1987, 779), some simple hypothetical examples were given which showed that traditional fixed base procedures could generate much higher measures of price increase than would be generated using the chain method, However, what is needed is empirical evidence. Numerical computation of alternative methods based on detailed firm data on individual prices and quantities where new goods are carefully distinguished would cast light on the size of the new good bias. Thus the firm oriented experiments suggested at the end of the previous section to cast light on the size of the substitution bias could also be used to study the size of the new good bias.

Another line of empirical work which would be of interest would be to collect industry price and quantity data on various major new goods (e.g., microwave ovens, video recorders, home computers, satellite dishes, etc.) and then attempt to rework the relevant price indexes in the light of this extra data.

J. Has the Theory of the Cost of Living Index been Exhausted?

Triplett (1988) (25) appears to answer the above question in the affirmative as the following quotation indicates: "The CCL index has been subjected to far more research, both theoretical and empirical, than any other price index topic in the history of index numbers. It seems to me that much of the fruit has been picked from this tree." It seems to me that the harvest is not yet over. A large gap in our current statistical system is in the area of the consumer's allocation of time. Many years ago, Reeker (1965) showed how the consumer's time constraint could be integrated into traditional consumer theory and he applied his new framework to cast light on a wide variety of applied economic problems. Additional applications can be found in a recent book edited by Juster and Stafford (1985). In order to implement Becker's theory, information on the consumer's allocation of time is required, broken up into:

(i) time at work

- time commuting to work,

(ii) time spent shopping,

- time spent at housework, and

(v) time spent at various leisure activities.

Since many productivity improvements involve efficiencies in the consumer's use of time (e.g., a new subway. line, an automated banking machine, electronic scanning of prices at the supermarket, etc.), it seems appropriate for Statistical Agencies to consider the implementation of a version of Becker's framework. Another area of household statistics which requires further theoretical development and empirical implementation is the area of income statistics: labor income should be decomposed into price and quantity components, income taxes should be taken into account in an appropriate manner and capital gains should be recognized as components of income. The point here is that most of the household measurement theory has concentrated on the commodity demand side and there has not been enough emphasis on the household factor supply and income sides.

K. Conclusion

Jack Triplett has presented the profession with an excellent survey of the price measurement literature since 1961. In sections 2 to 6 above, we augmented his survey by providing an overview of the pre 1961 literature on price measurement and index number theory in general. In sections 7 to 11, we discussed various topics where we did not seem to be in close agreement with some of the views expressed by Triplett in his paper. In some cases, we also provided a historical survey of these controversial topics: in section 8, we reviewed the early literature on the chain principle and various alternatives to it, and in section 10, we reviewed the early literature on the new good problem. It seems appropriate to conclude by listing three recommendations for Statistical Agencies where we agree with Triplett and then we shall list an additional four recommendations where we may be in some disagreement.

(1). Statistical Agencies should be encouraged to provide users with adequate printed documentation.

(2). The decomposition of labor income (on the household side) and labor payments (on the finn side Y into price and quantity components needs improvement: weighted index numbers should be used for quantities rather than unweighted man hours and man hours should be disaggregated into various occupational, educational and demographically homogeneous categories.

(3). In the context of the cost of living index, the flow of services concept should be extended to other classes of consumer durables in addition to housing.

(4). My preferred method for decomposing a value ratio into price and quantity components is the use of a superlative index number formula in the context of the chain method.

(5). Since it is usually impossible to collect complete price and quantity information for each value cell in the relevant accounting framework, it will be necessary to resort to some sort of sampling principle. The appropriate objects to sample are values within the relevant cell in the first period. These sampled values would then be broken up into detailed prices and quantities which would then be observed in the following period as well. Finally, Fisher ideal price indexes

should be constructed using these sampled values for the two periods and the corresponding quantity indexes should be constructed by deflating the relevant population value ratios by these (sample) price indexes. The entire procedure is explained in some detail by Pigou (1932, 75-77).

(6). The sizes of the substitution bias and the new good bias are still in doubt. The empirical experiments described in sections 9 and 10 above would be useful in determining the size of these biases.

(7). More empirical and theoretical work needs to be done on the household supply side; see the suggestions on incorporating Becker's theory of the allocation of time and on the construction of household real income indexes made in section 11 above.

1.2 Consumer Price indices in the United States

In the United States several different consumer price indices are routinely computed by the Bureau of Labor Statistics (BLS). These include the CPI-U (for all urban consumers), CPI-W (for Urban wage Earners and Clerical Workers), CPI-E (for the elderly), and C-CPI-U (chained CPI for all urban consumers). These are all built over two stages. First, the BLS collects data to estimate 8,018 separate item-area indices reflecting the prices of 211 categories of consumption items in 38 geographical areas. In the second stage, weighted averages are computed of these 8,018 item-area indices. The different indices differ only in the weights applied to the different 8,018 item-area indices. The weights for CPI-U and CPI-W are held constant for 24 months, changing in January of even-numbered years. The weights for C-CPI-U are updated each month to reflect changes in consumption patterns in the last month. Thus, if people on average eat more chicken and less beef or more apples and fewer oranges than the previous month, that change would be reflected in next month's C-CPI-U. However, it would not be reflected in CPI-U and CPI-W until January of the next even-numbered year. This allows the BLS to compute consumer price indices for each of the designated 38 geographical areas and for aggregates like the Midwest.

The United States Chained Consumer Price Index (C-CPI-U), also known as chain-weighted CPI or chain-linked CPI is a time series measure of price levels of consumer goods and services created by the Bureau of Labor Statistics as an alternative to the U.S Consumer Price Index. It is based on the idea that when prices of different goods change at different rates, consumers will adjust their purchasing patterns by purchasing more of products whose relative prices have declined and fewer of those whose relative price have increased. This reduces the cost of living reported, but has change on the cost of living; it is simply a way of accounting for a microeconomic "substitution effect." The "fixed weight" CPI also takes such substitutions into account, but does so through a periodic adjustment of the "basket of goods" that it represents, rather than through a continuous adjustment in that basket. Application of the chained CPI to Federal benefits has been controversially proposed to reduce the federal deficit. To understand "substitution bias", consider for example the price of Granny Smith apples. If the price of those

apples increases faster than the price of Red Delicious apples, consumers may decide to purchase more Red Delicious apples; this "lower-level" substitution bias is accounted for in the current CPI-U and CPI-W. However, if the price of apples increases faster than that of oranges, or if the price of apples declines more slowly than the price of oranges, consumers on average will respond by purchasing fewer apples and more oranges. This changes the "market basket" of goods they buy' this "upper-level" substitution is not accounted for in the traditional CPI until the next adjustment which could be up to two years later, but impacts the Chained CPI (C-CPI-U) the next month.

Impact on benefits: Various public and private organizations use CPI data for cost of living Adjustments (COLA) for programs like Social Security and for provisions of the tax code. Currently most programs are indexed to the CPI-U or the CPI-W. Changes in consumer prices are used to determine issues such as Cost of Living Adjustments, so any reduction in the official estimate of inflation would reduce payments to workers and retirees. If the official adjustment is greater than the inflation experienced by the recipients of the adjustment, they get an unearned benefit; if it is less than the real inflation, they are penalized – and the expense to those paying wages or retirement benefits are impacted in a complementary fashion. Beyond this, various thresholds in the tax code are also indexed to a CPI: if these thresholds grow slowly, tax receipts would likely increase. Application of chained CPI has been suggested as a means of reducing the US federal budget deficit by reducing the rate of growth of government benefits. The Moment of Truth Project estimates that moving to the Chained CPI would reduce the deficit by about $390 billion in the first decade alone, with roughly one third of the savings from Social Security, another third from increased federal revenue (via inflation-indexed tax provisions such as more slowly growing tax bracket thresholds), and the remaining savings from a combination of other spending programs and reduced interest on the debt. The Congressional Budget Office estimates switching to the chained CPI would save $340. Applying the chained CPI beginning in 2015 instead of 2014 and accompanying it with "low income protections" would save $230 billion.

History of proposals and controversy: In 1996, the Advisory Committee to Study the Consumer Price Index (the Boskin Commission) estimated that in 1996 CPI-W (used to adjust Social Security) over-estimated inflation 1.1 percent. The BLS responded by making changes to the CPI-U and CPI-W, which included an adjustment to compensate for upper-level substitution bias, performed each January of an even-numbered year. In 2002 BLS created the Chained CPI (C-CPI-U) that provides more frequent monthly adjustment for substitution bias. Proponents of the chained CPI include the Committee for a Responsible Federal Budget and the Heritage Foundation. It is also included in the recommendations of various bipartisan commissions designed to reduce the deficit such as Simpson-Bowles, Domenici-Rivlin, and the Gang of six. In 2012 and 2013 as part of the fiscal cliff negotiations, President Obama repeatedly proposed the application of chained CPI to social security benefits as a way to address budgetary shortfalls. This position was controversial with many, including Democrats and Social Security advocacy groups. Some oppose the measure for the reason that changing inflation metrics to the Chained

CPI would inappropriately cut the growth in benefits under programs like Social Security and Supplemental Security Income. Opponents include the AARP the American Federation of Government Employees, the AFL-CIO and Social Security works. They claim that the current CPI used for the elderly understates the inflation seniors experience, primarily because the elderly purchase more medical care than younger people, and medical care inflation has exceeded inflation in the rest of the economy. The Congressional budget Office said in 1998 that the CPI metric used for cost of living adjustment "grows faster than the cost of living".

According to the Committee for a Responsible Federal Budget, "moving to the Chained CPI would address this by using a superlative {CHAINED} index that updates expenditure weights and formulas in order to address consumer response to substitutions between categories." Since 2000 the chained CPI has on average measured inflation between 0.25 and 0.3 percentage points lower than CPI-U AND CPI-W. Opponents of the change note that while the difference is small, it compounds over time, making the reduction in outlays for COLSs for Social Security larger when looked at over a long time horizon. Opponents also claim that using CPI-W to adjust retirement benefits like Social Security does not properly estimate inflation for seniors, because the elderly have consumption patterns different from urban wage earners and clerical workers (studied for CPI-W). For example, the elderly consume roughly double the medical care of all urban consumers (studied for CPI-U AND C-CPI-U) and urban wage earners and clerical workers (for CPI-W), inflation in medical care has exceeded that in much of the rest of the economy. To adjust for this, the BLS computes a consumer price index for the elderly (CPI-E).

However, the CPI-E as an index has a number of flaws. For one, it covers a very small sample size and is in reality just a subset of the CPI-U rather than its own index. More importantly, there is substantial controversy about whether the CPI appropriately measures health care cost inflation – a problem which is particularly pronounced in the CPI-E. As CBO explains, it is unclear "whether the cost of living actually grows at a faster rate for the elderly than for younger people… some research suggests that BLS underestimates the rate of improvement in the quality of health care and that such improvement may be reducing the true price of health care by more than 1 percent a year. If that is the case, then all versions of the CPI overstate growth in the cost of living, with the overstatement especially large for the CPI-E." Chained CPI has moreover been criticized for its disproportionate impact on women who live longer, but typically have less savings than men. Concerns have also been raised regarding the impact of chained CPI on veterans, and persons with disabilities. The argument is that because veterans and the disabled collect benefits before retirement age, they would stand to lose a more significant share of income from Social Security and other programs over time. Furthermore, Chained CPI has been depicted as a regressive piece of social policy, as persons earning between $30,000 and $40,000 will be disproportionately impacted by the lowering of the inflation adjustment for income. In terms of distribution effect, moving to the chained CPI would reduce Social Security benefits by 3 percent for the bottom 60 percent of Social Security recipients and 4 percent for the top 40 percent of beneficiaries (per estimates for 2050 from the Social Security Administration). The

Tax Policy Center estimated that changing the Chained CPI would increase the taxes paid by 30 percent of the bottom 20 percent of the income distribution, 70 percent of the next 20 percent of the population, and nearly all of the people in the top 60 percent of the income distribution.

In January of each year, social security recipient receive a cost-of-living adjustment (COLA) to ensure that the purchasing power of social security and supplemental security income (SSI) benefits is not eroded by inflation. It is based on the percentage increase in the Consumer Price Index for Urban Wage Earners and Clerical Workers (CPI-W)". The use of CPI-W conflicts with this purpose, because the elderly consume substantially more health care goods and services than younger people. In recent years, inflation in health care has substantially exceeded inflation in the rest of the economy. Since the weight on health care in CPI-W is much less than the consumption patterns of the elderly, this COLA does not adequately compensate them for the real increases in the costs of the items they buy. The BLS does track a consumer price index for the elderly (CPI-E). It is not used, in part because the social security trust fund is forecasted to run out of money in roughly 40 years, and using the CPI-E instead of CPI-W would shorten that by roughly five years. The most recent December 2021 CPI reading hit 7 percent the highest level in over 40 years. In response Jerome Powell, chair of the Federal Reserve has begun Quantitative tightening with rate hikes expected to begin in March 2022.

The history of U.S. CPI: The CPI for various years are listed below with 1982 as the base year. A CPI of 150 means that there was 50 percent increase in prices, or 50 percent inflation, since 1982.

History of U.S CPI.

Year	**CPI**
1920	20.0
1930	16.7
1940	14.0
1950	24.1
1960	29.6
1970	38.8
1980	82.4
1982	**100**
1990	130.7
2000	172.2
2010	219.2
2020	258.0
2023	299.2

Source: U.S. Bureau of Labor Statistics.

Chained Index: Former White House Chief of Staff Erskine Bowles and former U.S senator Alan K. Simpson suggested a transition to using a "chained CPI" in 2010, when they headed the White House's deficit reduction commission. They stated that it was a more accurate measure of

inflation than the current system and switching from the current system could save the government more than $290 billion over the decade following their report. “The chained CPI is usually 0.25 to 0.30 percentage points lower each year, on average, than the standard CPI measurements”. However, the National Active and Retired Federal Employees Associations said that the chained CPI does not account for senior citizens’ health care costs. Robert Reich, former United States Secretary of Labor under president Clinton, noted that typical seniors spend between 20 and 40 percent of their income on health care, far more than most Americans. “Besides, social security isn’t in serious trouble. The social security trust fund is flush for at least two decades. If we want to ensure it’s there beyond that, there’s an easy fix – just lift the ceiling on income subject to social security taxes, which is now $113,700.” Replacing the current cost of living adjustment calculation with the chained CPI was considered, but not adopted, as part of a deficit-reduction proposal to avert the sequestration cuts, or fiscal cliff, in January 2013, but president Obama included it in his April 2013 budget proposal.

Why Is the Consumer Price Index Controversial? The Bureau of Labor Statistics (BLS) produces the Consumer Price Index (CPI). It is the most widely watched and used measure of the U.S. inflation rate. It is also used to determine the real gross domestic product (GDP).From an investor's perspective, the CPI, as a proxy for inflation, is a critical measure that can be used to estimate the total return, on a nominal basis, required for an investor to meet their financial goals. For several years, there has been controversy about whether the CPI overstates or understates inflation, how it is measured, and whether it is an appropriate proxy for inflation. One of the primary reasons for this contention is that economists differ on how they feel inflation should be measured.

KEY TAKEAWAYS

- For several years, there has been controversy about whether the CPI overstates or understates inflation, how it is measured, and whether it is an appropriate proxy for inflation.
- Over the years, the methodology used to calculate the CPI has undergone numerous revisions.
- Some critics view the methodological changes and the switch from a cost of goods index (COGI) to a cost of living index (COLI) as a purposeful manipulation that allows the U.S. government to report a lower CPI.
- There are three different definitions of the CPI; since these definitions are not operationally equivalent, each method of measuring inflation leads to different results.

How Is Inflation Measured? *The most commonly quoted inflation rate is the Consumer Price Index produced monthly by the U.S. Bureau of Labor Statistics. Officially the Consumer Price Index for All Urban Consumers, or CPI-U, the index reflects the changes in average prices paid for products and services purchased for day-to-day use by 93% of Americans, based on a sampling of retail prices. It also produces separate sub-indexes for food, energy, and all products except food and energy.*

The Controversy: Originally, the CPI was determined by comparing the price of a fixed basket of goods and services spanning two different periods. In this case, the CPI was a cost of goods index (COGI). However, over time, the U.S. Congress embraced the view that the CPI should reflect changes in the cost to maintain a constant standard of living. Consequently, the CPI has evolved into a cost of living index (COLI). Over the years, the methodology used to calculate the CPI has undergone numerous revisions. According to the BLS, the changes removed biases that caused the CPI to overstate the inflation rate. The new methodology takes into account changes in the quality of goods and substitution. Substitution, the change in purchases by consumers in response to price changes, changes the relative weighting of the goods in the basket. The overall result tends to be a lower CPI. However, critics view the methodological changes and the switch from a COGI to a COLI as a purposeful manipulation that allows the U.S. government to report a lower CPI.

John Williams, an American economist and analyst of government reporting, prefers an inflation measure calculated using the original CPI methodology based on a basket of goods having quantities and qualities fixed. David Ranson, another U.S. economist, also questions the official CPI's viability as an indicator of inflation. Unlike Williams, Ranson does not espouse the viewpoint that the CPI is manipulated. Instead, Ranson's view is that the CPI is a lagging indicator of inflation and is not a good indicator of current inflation. According to Ranson, increases in the price of commodities are a better indicator of current inflation because inflation initially affects commodity prices, and it may take several years for this commodity inflation to work its way through an economy and to be reflected in the CPI. Ranson bases his inflation measure on a commodity basket of precious metals. What is immediately apparent is that there are three different definitions of the CPI. Since these definitions are not operationally equivalent, each method of measuring inflation leads to different results.

Different CPI or Inflation Levels: The different methods of measuring inflation produce disparate indications of inflation for the same period. For example, Williams and Ranson conducted an academic study that compared the November 2006 Consumer Price Index Summary, which was published by the BLS, stating that "During the first 11 months of 2006, the CPI-U rose at a 2.2% seasonally adjusted annual rate (SAAR)." Williams' estimate of CPI for the same period was 5.3%, while Ranson's reported an 8.2% estimate. The differences between the BLS CPI and the figures attained by Williams and Ranson would be of sufficient magnitude whereby if the CPI is manipulated downward, the outcome of an investment plan could be less than effective. Therefore, a prudent investor may wish to obtain more insight and a better understanding of these disparate views of CPI and inflation measures and the effects they may have on their investment decisions.

16%

William's alternate CPI calculation showed that the U.S. inflation rate surged to over 16% in the Spring of 2022, or more than double official CPI figures.

Inflation and Profit Calculations: The rate of inflation also impacts the results investors and analysts calculate as they determine the returns on a portfolio. Investors must calculate their total required rate of return (RRR) on a nominal basis taking into account the effect of inflation. As the inflation rate increases, higher nominal returns must be earned to obtain a desired real

rate of return. The nominal annual required total return is approximated as the real required return plus the rate of inflation. For short investment horizons, the approximate method works well. However, for longer investment horizons (such as 20 years or more), a slightly different method should be used because the approximate method will introduce additional inaccuracy, which will compound as the investment_horizon increases. A more accurate estimate of the nominal annual required total return is calculated as the product of one plus the annual inflation rate and one plus the required annual real rate of return.

The following table measures the three respective methods of inflation figures with a 3% desired rate of real return. The results in the table show that as the difference between the inflation rate and the real rate of return increases, the difference between the approximated and the accurately determined total required returns increases.

Inflation Estimated By	BLS	Williams	Ranson
Inflation Rate (i)	2.2	5.3	8.2
Real Rate of Return Required (r)	3.0	3.0	3.0
i + r (approximate nominal rate)	5.2	8.3	11.2
1-[(1+i)(1+r)] ("accurate" nominal rate)	5.3	8.5	11.5

The effect of these differences is magnified as the investment horizon increases. The next table shows the effect on the value of $1 compounded for 10, 20, and 30 years at the various nominal total required returns determined for each inflation estimate. The first is the rate of return in each pair and is approximated; the second rate is more accurately determined.

Implications for the GDP: The GDP is one of many economic indicators investors can use to gauge the growth rate and strength of an economy. The CPI plays a vital role in the determination of the real GDP. Therefore, manipulation of the CPI could imply manipulation of the GDP because the CPI is used to deflate some of the nominal GDP components for the effects of inflation. CPI and GDP have an inverse relationship, so a lower CPI—and its inverse effect on GDP—could suggest to investors that the economy is stronger than it really is.

CPI and Government Spending: Governments also use CPI to set future expenditures. Many government expenses are based on the CPI and, therefore, any lowering of the CPI would have a significant effect on future government expenditures. A lower CPI provides at least two major benefits to the government:

1. Many government payments, such as Social Security and the returns from TIPS, are linked to the level of the CPI. Therefore, a lower CPI translates into lower payments—and lower government expenditures.
2. The CPI deflates some components used to calculate the real GDP—a lower inflation rate is reflective of a healthier economy. In other words, if the true rate of inflation is higher than the CPI as the government calculates it, then an investor's real rate of return will be less than originally expected as the unplanned amount of inflation eats away at gains.

Factors Adding to the Controversy: Many of the factors contributing to the CPI controversy are shrouded in complexities related to statistical methodology. Other major contributors to the controversy hinge on the definition of inflation and the fact that inflation must be measured by proxy. The BLS describes the CPI as a measure of the average change in the price of goods and services purchased by households over time on an average day-to-day basis. The BLS uses a cost of living framework to guide its decisions regarding the statistical procedures used to determine the CPI. This framework means that the inflation rate indicated by the CPI reflects the changes in the cost of living or the cost of maintaining a fixed standard of living or quality of life. In other words, it is a cost-of-living index.

The procedures used by the BLS to calculate the CPI are presented in detail in the *BLS Handbook of Methods,* Chapter 17, titled "The Consumer Price Index."

CPI and Consumer Behavior: To illustrate a simplified example of the effect of the CPI on consumer behavior and its different calculation methodologies, assume the following scenario where substitution happens at the item level within a category in keeping with the BLS methodology. Suppose that the only consumer good is beef. There are only two different cuts available: filet mignon (FM) and t-bone steak (TS). In the prior period, when prices and consumption were last measured, only FM was purchased, and the price of TS was 10% less than the price of FM. When next measured, prices had increased by 10%. A set of prices have been constructed to reflect this scenario and are presented in the table below.

Product	Price Per Pound Before Increase	Price Per Pound After Increase	Price Increase
Filet Mignon	$12.00	$13.20	10%
T-Bone Steak	$10.00	$11.00	10%

The CPI, or inflation, for this contrived scenario, is calculated as the increase in the cost of a constant quantity and quality of beef, or a fixed basket of goods. The inflation rate is 10%. This is essentially the way the CPI was originally calculated by the BLS, and it is the methodology used by Williams. This method is unaffected by whether consumers change their buying habits in response to a price increase. The current BLS methodology of calculating CPI takes into account changes in consumer purchasing preferences. In the simplified example presented, if there is no change in consumer behavior, then the calculated CPI would be 10%. This result is identical to that obtained with the fixed basket method used by Williams. However, if consumers change their purchasing behavior and fully substitute TS for FM, the CPI will be 0%. If consumers reduce their purchases of FM by 50% and purchase TS instead, the BLS calculated CPI will be 5%.The previous calculations showed that the CPI methodology used by the BLS, given the scenario and consumer behaviors described above, results in a CPI that depends on consumer behavior. Furthermore, an inflation level that is lower than an observed price increase can be measured. Although this example is contrived, similar effects in the real world are definitely within the realm of possibility.

What Should Investors Do About CPI's Flaws?: Investors could use the official CPI numbers, accepting the government-reported figures at face value. Alternatively, investors are faced with choosing either Williams' or Ranson's measure of inflation, implicitly accepting the argument that the officially reported figures are unreliable. Therefore, it is up to investors to become informed on the topic and take their own stance on the issue. Different CPI levels for a single price increase, depending upon consumer behavior, can be calculated using the BLS methodology, and it is not implausible that, depending upon consumption patterns, different rates of inflation may be experienced by a consumer. Therefore, the answer may be investor-specific.

What Is CPI-U? The CPI-U is the broadest measure of the consumer price index published by the BLS, representing the buying patterns of all urban consumers (encompassing roughly 93% of all American households).

What Is Shrinkflation? Shrinkflation is a hidden component of overall inflation that is rarely captured by traditional CPI measures. Shrinkflation occurs when a company sells a product for the same price it had, but reduces the amount of product contained. For instance, a bag of potato chips may cost $1 both this year and last; but now contains just 10 oz. instead of 12 oz.

12-month U.S. inflation for February came in at 6.0% and 5.5% once food and energy are stripped out. That's broadly in line with expectations but well above the Fed's 2% goal. On a month on month basis February's inflation was 0.4% or 0.5% without food and energy. That supports the narrative that inflation is not declining quickly, despite easing from peak levels of summer 2022.

Housing Costs: Part of the reason why inflation remains high is home prices. Shelter costs ran at 0.8% month-on-month for February and 8.1% year-on-year per the CPI's data. The CPI's measurement is at odds with other industry data sources due to calculation methodology.

Industry Data: Zillow estimates home values are up 6.8% year-on-year to February. RedfinRDFN +4.1% has house prices up 1.4% year-on-year to January. The S&P/Case Shiller National Home Price Index has prices up 5.8% for the year to December and on a declining trend, February's data may come in lower. Zillow is the only one of these other data providers showing data up to February at this point, but most other estimates are below the CPI's calculation of shelter costs. It's not just home prices, Rent.com has rental prices up 2.4% year-on-year to January 2023, the smallest increase in 20 months. All these figures are significantly below the CPI's 8.1% number.

Calculation Methods: This is likely a reflection of how the CPI calculates shelter costs, they use a panel approach sampling over a period of six months, which introduces a lag to current housing costs. To the extent that the CPI is looking at data on home prices from up to six months ago, it means they haven't picked up some softness in home prices since the summer. It now means that inflation could be overstated in CPI data. This because shelter costs make up over a third of the

inflation index weighting. It is also particularly relevant at turning points in house prices as we may be seeing currently. That also, correspondingly, implies that inflation was understated at peak levels, as the run up in home prices at that time wasn't fully captured.

Fed Reaction: The Fed is aware of this issue, and Fed Chair Jerome Powell has said he expects shelter costs to moderate in CPI data this year. Assuming that happens, the inflation picture could look different. Still, the timing is uncertain. Illustratively, if shelter costs were flat in the CPI data, then monthly inflation would be running at a level much closer to the Fed's target, although annual inflation would still some take time to trend down. Even assuming flat monthly shelter costs may be inaccurate at a time when industry sources see declining home prices and rents. Today's data won't reassure the Fed as inflation remains well above their target and is not falling as fast as hoped. Still the unique treatment of shelter costs within the CPI calculation is increasingly.

Personal Consumption Expenditures Price Index (PCEPI): Because of some shortcomings of the CPI, notably that it uses static expenditure weighting and it does not account for the substitution effect, the PCEPI is an alternative price index used by the Federal Reserve, among others, to measure inflation. From January 1959 through July 2018, inflation measured by the PCEPI has averaged 3.3 percent, while it has averaged 3.8 percent using CPI. In the European Union (EU), the main components of the HICP ARE: Food and non-alcoholic beverages (17 percent of the total weight); Housing, water, electricity, gas and other fuels (15 percent); Transport (15 percent); Miscellaneous goods and services (10 percent); Restaurants and hotels (10 percent); and Recreation and culture (9 percent). Other categories include Furnishings, household equipment and routine household maintenance (7 percent), Health (5 percent), Clothing and footwear (5 percent), Alcoholic beverages, tobacco and narcotics, communications and education account for the remaining 8 percent. Consumer Price Index CPI in the European Union increased to 123.90 points in January from 123.70 points in December of 2022.

A consumer price index is estimated as a series of summary measures of the period-to-period proportional change in the prices of a fixed set of consumer goods and services of constant quantity and characteristics, acquired, used or paid for by the reference population. Each summary measure is constructed as a weighted average of a large number of elementary aggregate indices. Each of the elementary aggregate indices is estimated using a sample of prices for a defined set of goods and services obtained in, or by residents of, a specific region from a given set of outlets or other sources of consumption goods and services. CPI in Euro Area is expected to be 105.19 index points by the end of this quarter, according to trading Economics global macro model analysts. Inflation measured by the Consumer Price Index (CPI) is defined as the change in the prices of a basket of goods and services that are typically purchased by specific groups of households.

What Is the Consumer Price Index (CPI)? The Consumer Price Index (CPI) measures the monthly change in prices paid by U.S. consumers. The Bureau of Labor Statistics (BLS) calculates the CPI as a weighted average of prices for a basket of goods and

services representative of aggregate U.S. consumer spending. The CPI is one of the most popular measures of inflation and deflation. The CPI report uses a different survey methodology, price samples, and index weights than the producer price index (PPI), which measures changes in the prices received by U.S. producers of goods and services.

KEY TAKEAWAYS

- The Consumer Price Index measures the overall change in consumer prices based on a representative basket of goods and services over time.
- The CPI is the most widely used measure of inflation, closely followed by policymakers, financial markets, businesses, and consumers.
- The widely quoted CPI is based on an index covering 93% of the U.S. population, while a related index covering wage earners and clerical workers is used for cost-of-living adjustments to federal benefits.
- The CPI is based on about 80,000 price quotes collected monthly from some 23,000 retail and service establishments as well as 50,000 rental housing units.
- Housing rents are used to estimate the change in shelter costs including owner-occupied housing that account for about a third of the CPI.

The Consumer Price Index, Understanding the Consumer Price Index (CPI): The BLS collects about 80,000 prices monthly from some 23,000 retail and service establishments. Although the two CPI indexes calculated from the data both contain the word urban, the more broad-based and widely cited of the two covers 93% of the U.S. population. Shelter category prices accounting for a third of the overall CPI are based on a survey of rental prices for 50,000 housing units, which is then used to calculate the rise in rental prices as well as owners' equivalents.

The owners' equivalent category models the rent equivalent for owner-occupied housing to properly reflect housing costs' share of consumer spending. User fees and sales or excise taxes are included, while income taxes and the prices of investments such as stocks, bonds, or life insurance policies are not part of the CPI. The calculation of the CPI indexes from the data factors in substitution effects—consumers' tendency to shift spending away from products and categories has grown relatively more expensive. It also adjusts price data for changes in product quality and features. The weighting of the product and service categories in the CPI indexes corresponds to recent consumer spending patterns derived from a separate survey. The CPI-U increased 6% over the 12-month period ending February 2023. That was an increase of 0.4% in February compared with a 0.5% increase in January 2023.

Types of CPIs: The BLS publishes two indexes each month. The Consumer Price Index for All Urban Consumers (CPI-U) represents 93% of the U.S. population not living in remote rural areas. It doesn't cover spending by people living in farm households, institutions, or on military bases. CPI-U is the basis of the widely reported CPI numbers that matter to financial markets. The BLS also publishes the Consumer Price Index for Urban Wage Earners and Clerical Workers (CPI-W). The CPI-W covers 29% of the U.S. population living in households with income derived predominantly from clerical employment or jobs with an hourly wage. CPI-W is used to adjust Social Security payments as well as other federal benefits and pensions for

changes in the cost of living. It also shifts federal income tax brackets to ensure taxpayers aren't subjected to a higher marginal rate as a result of inflation.

CPI Formulas: The more common CPI-U calculation entails two primary formulas. The first is used to determine the current cost of the weighted-average basket of products, while the second is used to analyze the year-over-year change.

Annual CPI Formula: To calculate the annual CPI, the BLS divides the value of a specific basket of goods today compared to one year ago:

$$\text{Annual CPI} = \frac{\text{Value of Basket in current year}}{\text{Value of Basket in Prior year}} \times 100$$

As mentioned earlier, the basket of goods and services used in the CPI calculation is a composite of popular items commonly purchased by Americans. The weight of each component of the basket is in proportion to how they are sold. The annual CPI is reported as a whole number, and the figure is often greater than 100 (assuming current market prices are appreciating).

Then, the BLS uses the current year's CPI and the prior year's CPI to calculate the inflation rate.

$$\textit{Inflation Rate} = \frac{\textit{New CPI} - \textit{Prior CPI}}{\textit{Prior CPI}} \times 100$$

The inflation rate can be calculated for a given month or annual period; in either case, the appropriate new and prior period must be selected. The inflation rate is reported as a percentage and is often positive (assuming current market prices are appreciating).

How Is the CPI Used? The CPI is widely used by financial market participants to gauge inflation and by the Federal Reserve to calibrate its monetary policy. Businesses and consumers also use the CPI to make informed economic decisions. Since CPI measures the change in consumers' purchasing power, it is often a key factor in pay negotiations.

The Federal Reserve: The Fed uses CPI data to determine economic policy. With a target inflation rate of 2%, the Fed may enact expansionary monetary policy to stimulate the economy should market growth slow, or enact contractionary monetary policy should the economy (and therefore prices) grow too quickly. In response to higher-than-desired inflation rates via the CPI, the Fed adjusts the Fed funds rate.

Other Government Agencies: The cost-of-living adjustments (COLAs) based on the CPI affect federal payments to the approximately 70 million Americans receiving Social Security and Supplemental Security Income (SSI) benefits. They also apply to federal pension payments, school lunch subsidies, and income tax brackets.

Housing: Mortgage rates (and other forms of long-term debt) are often impacted by rates set by government agencies. As the CPI increases and the government enacts policy changes to slow inflation, rates often increase. On the other hand, landlords may use CPI information to adequately assess what annual rent increases for renters should be.

Financial Markets: Financial market prices are driven by countless factors. One such factor is the CPI, as reactionary Fed policies directly impact economic growth, corporate profits, and consumer spending ability. A higher CPI often means that a less stringent government policy is generally in place. This means that debt is often easier to obtain for cheaper and that individuals have greater spending capacity. On the other hand, lower or decreasing CPI may indicate that the government may ease policy that helps boost the economy.

Labor Markets: The CPI and its components are also used as a deflator for other economic indicators, including retail sales and hourly/weekly earnings, to separate fundamental change from that reflecting change in prices. Employees may turn to CPI reports when approaching their employers for a raise based on nationwide increases in labor rates as well as pricing. Be mindful that the CPI is published using national data; employees may be more suited to using local data to better understand their specific situation. In addition, some workers covered by collective bargaining agreements may have their wages tied to changes in CPI.

The BLS reports the CPI on a fixed, monthly cadence. A schedule of prior and future releases can be found on the BLS website, and the CPI is always released at 8:30 a.m. Eastern Time.

CPI vs. Unemployment: In the broadest sense, the CPI and unemployment rates are often inversely related. This is not always the case in every economy, but the Federal Reserve often attempts to decrease one metric while balancing the other. For example, in response to the COVID-19 pandemic, the Federal Reserve took unprecedented supervisory and regulatory actions to stimulate the economy.

As a result, the labor market strengthened and returned to pre-pandemic rates by March 2022; however, this stimulus has resulted in the highest CPI calculations in decades. As a result of higher-than-targeted CPI calculations, the Federal Reserve began raising interest rates and tapering certain asset purchases. On one hand, these measures aim to slow economic growth, make it more expensive for consumers to acquire debt, and stem monetary supply growth. On the other hand, these additional expenses may burden households and make companies less profitable. All else being equal when the Federal Reserve attempts to lower the CPI, it runs the risk of unintentionally increasing unemployment rates.

Critiques of CPI Methodology: Because the CPI Index is so crucial to economic policy and decision-making, its methodology has long been controversial, drawing claims it either understates or overstates inflation. A panel of economists commissioned by Congress to study the issue in 1995 concluded the CPI overstated inflation and was followed by calculation changes to better reflect substitution effects. More recently, critics have claimed that adjustments for changes in product quality and features understate the CPI. According to the BLS, the particularly controversial hedonic adjustments, which use regression techniques to adjust prices

for new features on a relatively small proportion of the CPI items, have a net effect close to zero on the index.

As the traditional CPI-U calculation only measures inflation for urban populations, it remains a less-than-reliable source of data for individuals living in rural areas. In addition, the CPI does not explicitly state how different demographics may be impacted by inflation. For example, soaring education costs may adversely impact younger individuals, while the impact of increasing elderly care costs is felt by a different group of individuals. This notion is also widely attributable to individuals with varying degrees of income. For example, lower-income individuals who contribute more gross income towards necessities of shelter and food will skew differently than households with larger disposable income. For this reason, the CPI may not adequately reflect each individual's experience in regard to costs and changes over time.

What Is the Current CPI? The annual change in the CPI was 6% for the 12-month period ending February 2023. This was a 0.4% increase from the previous month.

How Is the Consumer Price Index Used? The CPI Index is an inflation indicator closely watched by policymakers and financial markets. A related CPI measure is used to calculate cost-of-living adjustments for federal benefit payments.

How Is the CPI Calculated? The Bureau of Labor Statistics samples 80,000 prices monthly to calculate the CPI, weighing the index for each product or service in proportion to its share of recent consumer spending to calculate the overall change in prices. The calculation also factors in the substitution effect as consumers shift spending away from the products rising in price on a relative basis. The CPI also adjusts for changes in product quality and features. The numbers are provided with and without seasonal adjustments.

What Are Some Criticisms of the CPI? Over the years, the CPI has frequently drawn criticism that it has either understated or overstated inflation. Because the CPI is based on consumer spending, it doesn't track third-party reimbursements for health care, and significantly underweights health care relative to its proportion in the GDP as a result. On the other hand, criticism concerning the quality adjustments used in the CPI has been widely discounted by economists.

The Bottom Line: The Consumer Price Index is an important economic metric. It measures the average change in prices paid by consumers over a period of time for a basket of goods and services. The index is calculated and published monthly by the Bureau of Labor Statistics. It is among the most common measures of inflation, indicating the health and direction of the economy. It also serves in other capacities, notably to help make adjustments to certain income payments, such as Social Security and pensions for federal civil service retirees.

1.3 Measuring inflation in Europe – The Harmonized Index of Consumer Prices (HICP)

The main task of the ECB is to maintain price stability. The ECB's Governing Council considers that price stability is best maintained by aiming for 2% over the medium term. In the euro area, the Harmonized Index of Consumer Prices (HICP) is used to measure consumer price inflation. That means the change over time in the prices of consumer goods and services purchased by euro area households. It is "harmonized" because all the countries in the European Union follow the same methodology. This ensures that the data for one country can be compared with the data for another.
The HICP is compiled by Eurostat and the national statistical institutes in accordance with harmonized statistical methods. The inflation rate is also used in assessing whether a country is ready to join the euro area.

Concept: The HICP aims to be representative of the developments in the prices of all goods and services available for purchase within the euro area by consumers. It measures the average change over time in the prices paid by people for a specific, regularly updated basket of consumer goods and services.

Which goods and services are covered? Basically all consumer goods and services purchased by means of monetary transactions come within the scope of the HICP. The technical name for these expenditures is "household final monetary consumption expenditure". This includes everyday items such as food, newspapers and petrol, durable goods such as computers and washing machines, and services such as hairdressing, insurance and rented housing. Following the 2021 Strategy Review, the Governing Council recommended that home-ownership costs be included in the Harmonized Index of Consumer Prices to better reflect people's experiences of rising prices. Implementing this will take time. The Governing Council welcomes the European Statistical System's related work on the statistical compilation of owner-occupied housing. This could pave the way for a move to an HICP that includes owner-occupied housing costs as the main index to be used for monetary policy. Until then, we will use available measures of inflation that include home-ownership costs to support our understanding of how prices are changing in the economy. This will inform the Governing Council's monetary policy assessments.

- Inflation measurement and our strategy review

  Only monetary transactions conducted directly by households are included in the HICP. This is important to remember when analyzing some expenditure categories, such as healthcare and education, where provision by the state is common. For example, if a student pays a fixed tuition fee to a university, only the amount of the fee is included in the HICP consumption basket even if the full cost of providing the education is much higher. Similarly, goods and services produced by households for their own consumption (such as home-grown vegetables) are not included. The full range of product groups covered by the HICP consumption basket is given by the European Classification of Individual Consumption by Purpose (ECOICOP/HICP).

What types of household are covered? The HICP covers the expenditure of all households within a country's economic territory. This includes spending by both resident and non-resident households in that territory (following the so-called "domestic concept"). Unlike some national consumer price indices, all types of households (including all income classes as well as foreign tourists) and all geographical areas are included.

The HICP and cost-of-living indices: In the literature on consumer price indices, two index types have a prominent role. **Fixed-basket price indices**, i.e. "Laspeyres price indices", define a basket of goods and services in the base period that is priced in each subsequent period. These goods and services are weighted according to their share in overall consumption in a certain base period. By contrast, in **cost-of-living indices** it is the "consumer utility" obtained from the purchases in the base period that is kept constant. The cost-of-living index therefore measures the change in expenditure necessary to maintain the utility of the base period. Conceptually, the HICP is a Laspeyres-type price index rather than a cost-of-living index. But the HICP is not a strict fixed-basket index. It measures the development of prices over time for fixed product categories according to the European Classification of Individual Consumption by Purpose (ECOICOP). Although these categories are fixed, the specific products that are included in particular categories may change over time. In other words, certain items may be removed from the basket and new ones may be added as they become relevant to household consumption expenditure. In the same way, and also different from a fixed basket price index, the HICP weights are updated every year to reflect – to the extent possible – the latest changes in expenditure patterns. In any case, the conceptual differences between the two types of price index do not generally lead to substantial differences in practice.

Quality of the HICP: The HICP is supported by a set of legally binding standards that cover the essential aspects of the index. Eurostat has a program of compliance-monitoring visits, during which the compilation practices of individual national statistical institutes are scrutinized. The HICP has been developed according to international standards and benefits from the experience of all EU Member States in consumer price statistics. It is the best measure of inflation in the euro area and is well-suited to assess the maintenance of price stability. However it is not perfect. Further work is ongoing to improve the quality and comparability of the index. The key priorities for the coming years are the integration of price indices of owner-occupied housing into the HICP and increased harmonization of methods for quality adjustment and sampling. Another main working area for Eurostat and the National Statistical Institutes is how to utilize new data sources (such as supermarket scanners, transactions and web scraping).

Prices - Basket of goods and services: In practice, prices cannot be collected for all of the millions of different goods and services available in the euro area. Sampling is used to derive a representative basket of goods and services to be priced every month. The national statistical institutes are responsible for defining the precise basket by selecting the most representative items for each product category. Therefore, each national HICP will cover bread and cars, but the type of bread and the brand and model of car may differ across countries, reflecting national consumption habits. Nowadays prices can also be obtained directly from retailers using supermarket scanners. However, in these cases the process of obtaining valid and representative price indices can be challenging.

Updating the basket: The HICP basket is updated on an annual basis to include new products that have become an important part of household consumption expenditure (such as music and video streaming services), while other products that are no longer representative (such as video tapes) are eliminated. In addition, within the year, old models of some products are replaced with newer ones. This occurs, for example, when sales of the old model are so low that its price falls sharply.

Collecting prices For the HICP, millions of prices are collected in shops and online thanks to automated web-scraping, cash desk scanners, and surveys. They cover the whole euro area and are grouped into up to 295 product categories. These price observations should reflect the prices actually paid by the consumer by including product taxes such as VAT, taxes on alcohol and tobacco, as well as reductions in prices. To combine all prices collected every month into a single figure for the euro area, information is needed on the relative share of each product category in households' spending.

Adjusting for changes in quality: The aim of the HICP is to measure "pure" price changes over time. Whenever a product's characteristics (e.g. package size and technical performance) change, observed prices are adjusted for these differences in specifications or quality in order to derive the pure price development. **Example**: Car prices may have gone up but new models often include, as standard, features that were previously sold as optional extras (for example, satellite navigation systems, air conditioning and airbags). In such cases, the price increase is due partly to an increase in quality and not only to inflation. If car prices went up 5% on average, but one fifth of this change was due to quality increases, then the HICP would reflect a 4% price increase for this product. National statistical institutes use several methods to account for quality adjustment, including methods based on expert judgments, regression techniques ("hedonic methods") and methods that derive estimates of the pure price change from similar products, for

example those that are available at unchanged quality ("bridged overlap method").While the effect of quality changes is usually small for many items in the HICP (e.g. butter), for some items the effect can be large (e.g. for cars and computers). Work is underway in Eurostat to ensure that all countries use comparable techniques for quality adjustment.

WEIGHTS - Product weights: The HICP for each euro area country is calculated as a weighted average of price changes for a wide range of product groups, using the respective share of each group in the total expenditure of all households for the goods and services covered by the index. The information used to calculate the weight of each product group is collected mainly from national accounts and cross-checked and updated with information from other sources (e.g. VAT revenue statistics and households budget surveys). The product group weights are representative for the total household consumption expenditure at national level. As such, for each country they capture national consumption habits, which may depend on climate, product taxes, lifestyles, cultural traditions and other factors (e.g. the availability of products).The HICP takes into account the consumption expenditure of all the households in a country and not some "typical" household (see "Concept" section above). For example, expenditure on petrol is included for those households with a car and, at the same time, expenditure on bus tickets is included for those that use public transport. What is important in the HICP is its composition, which encompasses the total consumption expenditure of all households together. In order to keep the index up-to-date, product weights are updated regularly to reflect changes in consumer expenditure patterns. By law, the weights are updated every year.

From national to euro area HICP: The HICP for the euro area as a whole is calculated as an average of the national HICPs for the euro area countries, weighted by the **countries' relative household consumption expenditure shares in the euro area total**. The weights are updated annually and are derived from national accounts data. The euro area HICP covers those EU Member States whose currency was the euro during the time period to which the data relate. When a country joins the euro area, the national HICP for that country is included in the euro area HICP using a chain index formula. The HICP is compiled by Eurostat together with the National Statistical Institutes of the Member States of the European Union. Currently 34

countries (all EU Member States, Iceland, Norway, Switzerland, the USA, and the European countries seeking to join the EU: North Macedonia, Serbia and Turkey) compile national HICPs.

Break down of data: Two breakdowns are available, both based on the same 90 product groups:

1. **By purpose of consumption**: data is broken down according to the European version of the international Classification of Individual Consumption by Purpose (COICOP) classification, the so-called ECOICOP. Most statistical offices around the world use a variant of COICOP. HICP breakdown by purpose of consumption: latest data for euro area.

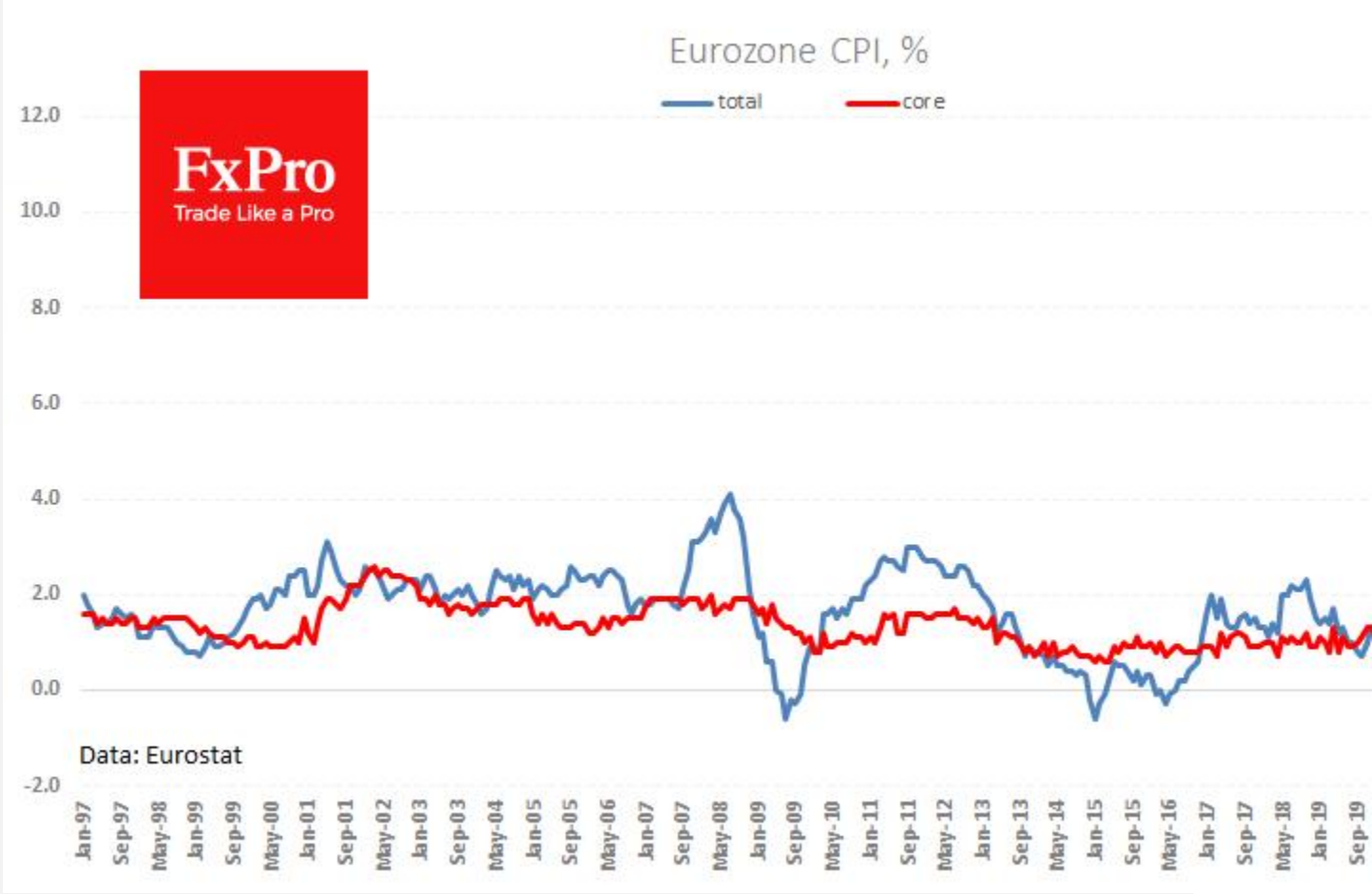
2. **By type of product**: this is the breakdown generally used by the ECB and referred to in its Economic Bulletin. This breakdown divides the basket into components comprising product groups that are assumed to be influenced by certain economic developments. For example, developments in energy prices are grouped together since they are closely related to oil price movements. Food prices are divided into processed and unprocessed food, because prices of unprocessed food are more strongly influenced by factors such as weather conditions and seasonal patterns than those of processed food. Services prices are subdivided into five components which, on account of different market conditions, typically show distinct developments. HICP breakdown by type of product: latest data for euro area.
Eurostat also publishes some special aggregates, such as the overall index excluding unprocessed food and energy and the overall HICP excluding tobacco.

Seasonal adjustment: Many prices show a seasonal pattern. For example, end-of-season sales often cause the HICP to fall systematically in spring and summer. In order to extract the "news" from these seasonal changes and therefore aid short-term inflation analysis, the ECB compiles seasonally adjusted figures for the main HICP components. These data are published on the ECB's website on the same day as the regular HICP figures are published.

Release Calendar: HICP data are published every month by Eurostat, the statistical office of the European Union. At the end of each month, a euro area flash estimate for headline inflation is released for that month. This is accompanied by flash estimates for the main components of the euro area HICP: energy, food (including alcohol and tobacco), non-energy industrial goods and services. Flash estimates for the special aggregates "all items excluding energy" and "all items excluding energy and food" are provided as well. The data are available for the euro area as a

whole as well as for its Member States. The flash estimate is followed by a full release in the middle of the month, which comprises all country and euro area breakdowns and special indices.

Revisions: HICPs are not normally revised. The HICP for the current month is final with its full release. Revisions are only made in the event of errors. Further revisions of the national HICPs have to be agreed with Eurostat. Although commodity and energy prices have retreated from their highs and supply chains have recovered over the past year, inflation remains a problem. This thesis was confirmed today for the euro zone. Eurostat estimated overall price growth in the Euro region at 8.5% y/y. This is a step down from 8.6% a month earlier and a peak of 10.6% in October, but economists, on average, expected to see a slowdown to 8.3%.



New heights of euro area's Core-CPI

Even more attention should be paid to the continued growth of core CPI, from which energy and food are excluded. Its annual growth rate accelerated to 5.6% against expectations of a 5.3% deceleration. This acceleration represents a much bigger problem than the jump in energy prices. For the last 17 months, it has been above the 2% target. At the same time, the Euro-region's unemployment rate of 6.7% is very low. This combination dramatically increases the risks of stalling inflation expectations. The only way for the central bank to tackle them is to rein in the economy by pushing it towards contraction to reduce the domestic pressure on prices. If the ECB

is serious about fighting inflation, it must act sharper and longer in raising rates and quantitative tightening. That sounds like good news for the euro, but traders should be aware that markets are quite prepared for the current publication from earlier in the week when individual country data was released. In addition, the historically positive correlation between EUR/USD and stock indices should be noticed: declines in equity indices are weighing on the pair today.

1.4 The Sierra Leone Consumer Price Index (SLCPI)

Inflation measured by consumer price index (CPI) is defined as the change in the prices of a basket of goods and services that are typically purchased by specific groups of households. Inflation is measured in terms of the annual growth rate and in index form, 2015 base year with a breakdown for food, energy and total excluding food and energy. Inflation measures the erosion of living standards. A consumer price index is estimated as a series of summary measures of the period-to-period proportional change in the prices of a fixed set of consumer goods and services of constant quantity and characteristics, acquired, used or paid for by the reference population. Each summary measure is constructed as a weighted average of a large number of elementary aggregate indices. Each of the elementary aggregate indices is estimated using a sample of prices for a defined set of goods and services obtained in, or by residents of, a specific region from a given set of outlets or other sources of consumption goods and services.

- Overview
- Geographic coverage and sample selection for the CPI
- Outlets specification, products/items specification or varieties.
- What data must be collected for CPI pricing

Overview/Introduction

- The SLCPI (all urban) measures pure price change (12 COICOP functions) of a basket of representative products and services consumed by the residents (households) of Sierra Leone, which have been provided at constant quality. It is the main measure of inflation in the country and changes in the CPI are used as indicators for the rate of inflation for the economy as a whole. CPI is also a high profile statistics of national and international importance used widely in economic decision particularly monetary policy.
- Therefore, high inflation rates adversely affect not only the economic performance of a country, but also increase the consumption expenditure of households which ultimately affect the welfare of the population especially the poor.

Main Aim/Objective (s).

- To measure the levels of increases or decreases in the prices of the items consumed and in essence ascertain the cost of living for the inhabitants of Sierra Leone.
- The Consumer Price describes the price development of goods and services purchased in Sierra Leone by households resident in Sierra Leone.
- It measures the proportionate or percentage changes in the prices of a representative basket of goods and services over time.
- For a better understanding of the CPI and labor staff.

Geographic Coverage and sample selection

Geographic Coverage

- The index includes sampled outlets from five urban towns representing the four geographic regions of the country. The district headquarter towns: Kenema and Koidu (Eastern region), Bo (Southern region), Makeni (Northern region), and Freetown (Western Area). The weights applied to the computation of the composite index refer to the entire country divided into the four regions.

Sample Sizes

- Five urban centers were purposefully selected for data collection. The four centers already used for price collection, Freetown, Bo, Kenema, and Makeni were retained. Koidu which is a major diamond mining town was added. For each product three outlets were selected for price collection. However, for a few products price collection was done in less than three outlets due to centralization of services.

Outlet and Item Specification (varieties)

- Item selection
- Product Specification: This is the totality of essential characteristics of a product which completely describe it.
- The products specification is very precise and detailed, including a range.
- Product here is differentiated from a produce in that it is a good or service that takes in to account value added, packaging and all other futures.
- Thus a single piece of toilet soap as a product is different from the same brand size of soap coming from in a pack of three or four. Similarly, long grain rice in a one-kilogram bag as a product is different from the same long grain rice in a five-kilogram bag.
- In many but not all cases, the same basket of items will be priced for the updated CPI. As for the current CPI. The updated CPI resulted in an increase in the number of market basket items captured within the index.

- It is essential however that the specifications and description of every item whether new or existing are checked and where necessary updated.
- In selecting an item variety to be priced in a sampled outlet/shop, the item variety selected for pricing should be the one that closest matches the item's specification.
- For observed quantity: Write down the numeric figure of the weight, size or units of the products without the unit of measurement. This is important in arriving at unit price of products particularly when there is a range in the specification.

Observed Unit of Measurement

- This is the unit that relates to the observed quantity. It is either in gram or kilogram for weight, liter for volume, meter for length etc. Make sure you indicate the unit for the quantity observed.
- If more than one item meets the specification you should choose the one that is most sold – you will need to ask the shop assistant/owner to find this out. Do not assume the most sold is always the cheapest!
- In all cases, you should write down the complete item description i.e. shop name, quantity, package size, brand, model number, material composition, or item description, as appropriate.
- Even if the item specification has not changed e.g. men's T-shirt 100% cotton, the actual item selected should be reviewed periodically to ensure the most sold items are priced.
- This is particularly true for electronic goods, TVs and household durable goods. Where models change frequently.

Initial Outlet (shop) Selection

- The outlets/shops selected should be
- Located in areas which are typical of where most households shop
- Be representative for the type of good or service being sold
- Are believed to be long lasting i.e. are not expected to close down in the near future.
- Market stalls are an exception, while individual market stalls may change frequently, the location of markets does not.
- While sampling of shopping districts and outlets can be based on business registers, in most cases local knowledge is used.

Some examples of products and outlet specifications

Product	**Required Specification**	**Required Outlet**
Refrigerator	Refrigerator with freezing compartments: 120-140 liters, length 60cm and width 55cm	Specialized shop, supermarket
Freezer Upright	Freezer: 160 liters, width	Specialized shop, supermarket

	60cm and height 120cm	
Doughnut	In plastic bag, paper bag, sold loose (250-300g), ball, ring fried (oil), wheat flour.	Open market, neighboring shop, supermarket

Description of outlets

No.	Outlet Type	Examples	Description of some outlet examples
1.	Larger Shops	Hyper shops, Supermarkets, Department stores, etc.	**Hypermarket:** A hypermarket is a very large store: a very large self-service store that sells products usually sold in department stores as well as those sold in supermarkets, e.g. clothes, hardware, electrical goods, and food. In commerce, a hypermarket is a superstore which combines a supermarket and a department store. The result is a very large retail facility which carries an enormous range of products under one roof, including full lines of groceries and general merchandise. In theory, hypermarkets allow customers to satisfy all their routine weekly shopping needs in one trip. **Supermarkets**[1]: A supermarket, also called a grocery store, is a self-service store offering a wide variety of food and household merchandise, organized into departments. It is larger in size and has a wider

			selection than a traditional grocery stores and it is smaller than a hypermarket or superstore. The supermarket typically comprises meat, fresh produce, dairy, and baked goods departments along with shelf space reserved for canned and packaged goods as well as for various nonfood items such as household cleaners, pharmacy products, and pet supplies. Most supermarkets also sell a variety of other household products that are consumed regularly, such as alcohol (where permitted), household cleaning products, medicine, clothes, and some sell a much wider range of nonfood products. **Department stores**: A department store is a retail establishment which specializes in satisfying a wide range of the consumer's personal and residential durable goods product needs; and at the same time offering the consumer a multiple choice merchandise lines, at variable price points, in all product categories. Department stores usually sell products including apparel, furniture, home appliances, electronics, and additionally select other lines of products

			such as paint, hardware, toiletries, cosmetics, photographic equipment, jewelry, toys, and sporting goods. Certain department stores are further classified as discount department stores. Department stores are usually part of a retail chain of many stores situated around a country or several countries.
2.	**Medium & Small shops**	**Minimarkets, Kiosks, Neighborhood shops, Grocery stores, Convenience stores, etc.**	**Minimarket:** Minimarket is a market with relatively small numbers of shops in it. Though the size is not as large as a normal market, it still can be convenient for shoppers to have a variety of shops in a small place. **Kiosk**: A kiosk is a booth with an open window on one side. Some vendors operate from kiosks, selling small, inexpensive consumables such as newspapers, magazines, lighters, street maps, cigarettes, and confections. **Neighborhood shop**: Retail store designed to blend in with the surrounding neighborhood and specializing in local tastes and needs. **Grocery store**: A grocery store is a store established primarily for the retail of food. A grocer, the owner of a grocery store, stocks

			different kinds of foods from assorted places and cultures, and sells them to customers.
3.	**Market**	**Open markets, Covered markets,, Wet markets, etc.**	**Open market:** Any market where buying and selling can be carried on without restrictions as to price and in many cases entry. **Wet market**: A wet market is generally an open food market. The floors and surroundings are often routinely sprayed and washed with water – to the extent of flooding it at frequent intervals – which gave it the name "wet market".
4.	**Street Outlets**	**Mobile shops, street vendors, etc.**	**Mobile shops:** Mobile shops consist of individuals or groups that provide a service, sell merchandise or food on a regular basis from a registered vehicle. These were previously known as 'hawkers'. A mobile shop is a vehicle whether self-propelled or not, standing in or on a road and from which products are offered or exposed for sale and takeaway. These products include perishable foods, or food preparation on site for the purpose of selling. This category does not include the consumption of food in or at the vehicle. Street vendors are business people who sell

			their wares in the open air rather than in a shop or store. In many cases, the vendor either has a small stand that can be secured when not in operation, or makes use of a cart that can be removed from the street at the end of the business day. Sometimes referred to as a peddler, the street vendor is commonly found in metropolitan areas, outdoor events, and sometimes at public beaches. A street vendor or hawker is a vendor of merchandise that can be easily transported. **Street vendors**: A street vendor is broadly defined as a person who offers goods or services for sale to the public without having a permanent built up structure but with a temporary static structure or mobile stall (or head load). Street vendors may be stationary by occupying space on the pavements or other public/private areas, or may be mobile in the sense that they move from place to place carrying their wares on push carts or in cycles or baskets on their heads, or may sell their wares in moving bus etc.
5.	**Bulk and discount shops**	**Wholesale stores, Discount shops, etc.**	**Wholesale stores:** A store run by wholesale dealers that sell goods directly to

			consumers. In most cases, by passing over brokers and retailers, they sell goods with lower prices than usual retailers. **Discount shops**: A store that sells merchandise, especially consumer goods, at a discount from the manufacturer's suggested retail price. Also called discounter, discount house.
6.	**Specialize shops**	**Supply shops, Hardware shops, Furniture shops, etc.**	**Supply shops:** A store where professionals can purchase tools and materials for their business, such as building supply shop where builders can purchase materials for building houses and related structures. **Hardware shops**: Hardware stores, sometimes known as DIY stores, sell household hardware including: fasteners, hand tools, power tools, keys, locks, hinges, chains, plumbing supplies, electrical supplies, cleaning products, housewares, tools, utensils, paint, and lawn and garden products directly to consumers for use at home or for business. Many hardware stores have specialty departments unique to its region or its owner's interests.
7.	**Private service providers**		Taxi cabs, hotels,

			restaurants, private schools, private hospitals, etc.
8.	**Public or semi-public service providers.**		Water suppliers, electric power companies, public schools, public hospitals, etc.
9.	**Other kinds of trades and outlets**	**Online (Internet) shopping sites, catalog orders and other trades and/or outlets that are outside of scope of outlet types 1 to 8.**	**Online (Internet) shopping sites:** Online shopping is the process consumers go through to purchase products, goods or services over the Internet. An online shop, e-shop, e-store, Internet shop, web-shop, web-store, online store, or virtual store evokes the physical analogy of buying products or services at a bricks-and-mortar retailer or in a shopping mall. **(Mail) Catalogue orders**: Mail order is a term which describes the buying of goods or services by mail delivery. The buyer places an order for the desired products with the merchant through some remote method such as through a telephone call. Then, the products are delivered to the customer. The products are typically delivered directly to an address supplied by the customer, such as a home address, but occasionally the orders are delivered to a nearby retail location for the customer to pick up. Some merchants also allow the goods to be

			shipped directly to a third party consumer, which is an effective way to send a gift to an out-of-town recipient.

Difference between a supermarket and a shopping mall.

A supermarket is a single organization that sells everything in it. It gets products from various suppliers and companies and sells it to customers. A shopping center/mall on the other hand is a hub where many different brands, organizations and businesses have their own sections so as to offer their own products or something they can offer with a difference.

Chapter 2: REVIEW OF RELATED LITERATURE.

2.0 Introduction

The consumer price index (CPI) is the main measure of inflation in Sierra Leone; changes in the CPI are used as an indicator of the changes in the rate of inflation for the economy as a whole. The CPI is a high profile statistics of national and international importance used widely in economic policy decision-making particularly monetary policy. High inflation rates adversely affect not only the economic performance of the country but also increase the consumption expenditure of households, which ultimately affect the welfare of the population, especially the poor. Thus the need to monitor inflation and to produce reliable and accurate CPI cannot be over-emphasized.
The Sierra Leone National Consumer Price Index (all urban) measures pure price change in the 12 functions of products and services consumed by the residents of Sierra Leone, which have been provided at constant quality. The overall aim is to measure the levels of increases or decreases in the prices of the items consumed and in essence ascertain the cost of living for the inhabitants of the country.

In Sierra Leone, inflation is being monitored on a monthly and annual basis based on the CPI published by Statistics Sierra Leone. The Composite Consumer Price Index is computed as a weighted average of the different center sub-indices. The expenditure weights were obtained from the 2017/2018 Sierra Leone Integrated Household Survey (SLIHS) Income and Expenditure Module. The Consumer Price Index (CPI) basket in Sierra Leone currently covers a total of 400 items; and the CPI is estimated as a weighted aggregate of a fixed basket of these 400 goods and services popularly consumed in Sierra Leone. The index covers sampled outlets from five urban towns representing the four geographic regions of the country: Kenema and Koidu- Eastern province, Bo-Southern Province, Makeni-Northern Province and Freetown-Western Area. The current CPI reference year is 2007. All prices collected are the prevailing retail market prices from six (6) markets in Freetown, three (3) Markets in Bo Town, three (3) markets in Kenema Town, three markets (3) in Koidu and three (3) markets in Makeni Town for weekly prices, making a total of 18 markets as data collection centers for the CPI exercise in Sierra Leone.

These aggregates are determined using the Classification of Individual Consumption by Purpose (COICOP) for Household Final Consumption Expenditure with 2007 as the new base year. The COICOP classification which is an international standard to disaggregate the CPI has 12 functions excluding the function of “All Items” which is the aggregate index of all functions. The 12 COICOP functions are:

1. Food and non-Alcoholic Beverages
2. Alcoholic Beverages, Tobacco and Narcotics
3. Clothing and Footwear
4. Housing, water, electricity, gas and other fuels

5. Furnishing, household equipment and maintenance
6. Health
7. Transport
8. Communication
9. Recreation and culture
10. Education
11. Hotels and Restaurants
12. Miscellaneous goods and services

Consequently, a CPI is computed for each of the 12 functions using the items in the basket as classified according to COICOP. It is important to note that an average price is determined for each item or row of products in the classification and the corresponding expenditure weight is used to compute the CPI of a particular function. The CPI for All Items is computed using the average price and expenditure weight for each item at regional level as mentioned above. The National CPI is determined using the average of the regional CPIs' for each function and for all items in the basket. The indices for products are compiled using a geometric mean formula, while the aggregated indices are computed using the Modified Laspeyres Formula.

There are 400 products and services in the revised basket compared to 251 in the old basket. Prices for sixty four of these products are collected weekly in markets in all centers. Prices for the others are either collected monthly, quarterly or annually. These prices include taxes, discounts and rebates where applicable. The revised CPI price data collection takes place in the five main urban towns in Sierra Leone; Freetown, Bo, Kenema, Makeni and Koidu representing the four regions of the country. The five urban towns were purposefully selected (Kenema and Koidu represents the Eastern Region; Bo represents the Southern Region, Makeni represents the Northern Region and Freetown represents the Western Area) because they together represent about 80 percent of total urban household consumption expenditure. The weights for the combined CPI refer to the total household consumption expenditure for the entire country divided into the four regions. Thus four regional indices are computed and combined into the all urban national CPI using the expenditure share of each region as aggregation weights. The CPI survey is divided into twelve main surveys organized according to the 12 functions of the classification of individual consumption by purpose (COICOP). Prices for Product and services selected for the survey within each function are either collected on a weekly basis in market outlets, monthly, quarterly, or annually depending on the variability of prices of the items.

The central bank, the Bank of Sierra Leone (BSL), has the legal mandate to spare-head efforts to reduce inflation and to maintain stable prices in the country. Being the monetary authority in the macroeconomic system, BSL enjoys the monopoly of being the sole issuer of currency-notes and coins in the economy-which are legal tender-the Leone (Le). Commercial banks are required to hold their reserves as deposits with the central bank, which becomes the "banker's bank" with all the reserves of the country. The Bank of Sierra Leone (BSL)'s monetary policy objective is to maintain a low level of inflation. To achieve its objective, the BSL targets reserve money growth through various means such as open market operations, etc. Since 2010, the annual average of inflation has been in the double digit range; and in September 2010 the year-on-year rate of inflation was about 16 percent. Hence, it becomes more important for policy makers to identify the real causes of

inflation and design pro-active strategies to stabilize prices accordingly. This report will therefore be handy in the design of such policies to tackle inflation in the economy.

When inflation crosses reasonable limits, it produces negative effects. It reduces the real value of money, which is the medium of exchange. This results in uncertainty of the value of gains and losses of borrowers and lenders as well as buyers and sellers. The increasing uncertainty discourages savings and investment. Savings are discouraged as inflation reduces the real rate of return on financial assets. This again leads to lower investment and lower economic growth. Not only can high inflation erode the gains from growth, it also leaves the poor worse off and increases the divide between the rich and the poor in an already improvised country devastated by the 10-year civil conflict. As already mentioned, the importance of inflation lies on its consequences, especially its impact on welfare and hence on poverty. As a result inflation's effects on an economy are manifold and can be simultaneously positive and negative. When the price level rises, each unit of currency buys fewer goods and services, which means that the purchasing power of money income is eroded. However, inflation is not necessarily a bad thing within certain predictable limits; what is worse about inflation is when it becomes too high and very much unpredictable, which does have wider ramifications in the macroeconomic environment.

The CPI is the main measure of inflation. Changes in the CPI are used as an indicator of the changes in the rate of inflation for the economy as a whole. The CPI is a high profile statistics of national and international importance, and it is used widely in economic policy decision-making particularly monetary policy. High inflation rates adversely affect not only the economic performance of the country but also increase the consumption expenditure of households. Thus the need to monitor inflation and to produce reliable and accurate CPIs cannot be over-emphasized. The consumer price index (CPI) is used for many purposes by government, businesses, labor unions, researchers, and the general public. Since price instability introduces uncertainty into economic analysis and decision-making, the main uses of the CPI relate to efforts to minimize this uncertainty. The CPI is used as a measure of the cost of living and hence the welfare of the people; it is also used a deflator for national accounts aggregates such as GDP.

2.1 The Consumer Price Index: Conceptual Issues and Practical Suggestions.

Committees of economists have long recommended that the U.S. Bureau of Labor Statistics (BLS) should establish a cost-of-living index as the measurement objective for the Consumer Price Index, rather than regarding the CPI as measuring changes in the cost of purchasing a fixed basket of goods, and should undertake the research and operational changes necessary to move the CPI closer to that goal. A committee led by George Stigler made this recommendation back in 1961 (Stigler, 1961). The Boskin commission, appointed by the Finance Committee of the U.S. Senate, echoed this recommendation in its 1996 report (Boskin et al., 1996).[1] The Consumer Price Index was traditionally based on the concept of measuring the change in a household's cost of purchasing a fixed basket of goods and services in the face of a change in prices between two periods—in shorthand, a cost-of-goods index. A more ambitious objective is to base the index on the concept of measuring the change in the cost of maintaining a household's standard of living at some specified level—a cost-of-living index. In an aggregate CPI, price and expenditure data must be combined to produce an estimate that reflects some measure of average change, in either the cost of goods purchased or the cost of maintaining a given living standard for all or

for some subgroup of households. But the aggregation of index numbers over the population or over groups is not an issue that separates cost-of-living and cost-of-goods indexes. Shortly after the Boskin report was issued, the Bureau of Labor Statistics told Congress that it had, in fact, been using cost-of-living theory for some time to make decisions about the index and accepted the cost-of-living index as its measurement objective for the Consumer Price Index (U.S. Bureau of Labor Statistics, 1997). But it also pointed out that "the cost of living is a theoretical construct . . . not a single or straight-forward index formula readily amenable to practical use," and it noted that a wide range of issues had to be confronted in moving the CPI closer to a cost-of-living index.

The Bureau of Labor Statistics asked the Committee on National Statistics of the National Academy of Sciences to establish a panel charged to explore the conceptual and statistical issues that arise in constructing a cost-of-living index; to assess the advantages and difficulties involved in establishing the cost-of-living index as the measurement objective of the CPI; and to make recommendations to the BLS about its operational, data collection and research programs. This article is not a summary of the panel's report (National Research Council, 2002).2 Rather, out of a large number of issues that the panel treated, the author have elected to discuss four that are both controversial and particularly important: 1) addressing the problem of consumer substitution among goods over time;) defining the universe of goods and services that should be included in the CPI; 3) adjusting the CPI to take into account quality changes in existing goods; and, briefly, 4) handling the introduction of new goods. While I will present the panel's recommendations and the reasoning behind them, I add my own commentary and interpretation and in some cases expand on the material in the report. One feature of the panel that distinguished it from its predecessors—the Boskin commission and Stigler committee—was the inability of panel members to reach unanimous agreement that the cost-of-living index should be the measurement objective for the Consumer Price Index. The panel's report identifies and analyzes some theoretical and measurement difficulties that affect our ability to produce conceptually consistent and accurate measures of a cost-of-living index. Some members of the panel concluded that these limitations are serious enough to make it infeasible to convert into monetary terms the effects on living standards from changes in the prices and qualities of goods. Other members, myself included, came away convinced that despite these difficulties, it was, on balance, still desirable to aim the CPI at measuring a cost-of-living index, with the recognition that the measure will be an approximation. Despite our differences on this subject, however, the panel reached unanimous agreement on a wide range of recommendations to the Bureau of Labor Statistics aimed at improving the design and construction of the Consumer Price Index.

The Problem of Substitution: A cost-of-goods index starts with a certain basket of goods selected to be representative of total consumption expenditures during some particular point in time and then examines what it would cost to purchase this same basket of goods in a different period.3 The Laspeyres version of the cost-of-goods index uses a basket of goods that represents the pattern of consumption at some time in the past and then measures what it would cost to purchase that basket of goods up to the present. A Paasche index uses a basket of goods that represents the pattern of consumption in the present, and then projects backward what it would have cost to purchase that basket of goods in some past period. Because the Laspeyres index neglects the ability of consumers to mitigate the welfare effect

of price increases through substitution among goods, it overstates the cost of maintaining the consumer's original, or reference period, standard of living.

Conversely, because a Paasche index measures how much it would have cost in the past to purchase the basket of goods representing current consumption, it effectively assumes that people had already made the substitutions between goods in the past that they have now made in the present, and thus understates the cost of maintaining the consumer's current, or comparison period, standard of living. These relationships have often led to the statement that a Laspeyres index should always exceed a Paasche index. Empirical studies have shown that Laspeyres indexes do indeed tend to produce a higher measured rate of inflation than Paasche indexes, at least in most years, and this evidence is often viewed as supporting the importance of substitution behavior in explaining changes in the pattern of consumer purchases. But notice that the Laspeyres index overstates the cost of maintaining the reference or past period standard of living while the Paasche index understates the cost of maintaining the comparison or current period's standard of living. When those two standards of living are significantly different— due to perhaps to the size and pattern of relative price shifts or to changes in income—it is at least conceptually possible that a change in the Paasche index could exceed a change in the Laspeyres index.

Superlative Indexes: Clearly, the problem is to find an index that makes some allowance for substitution. If the demand functions for all goods were known, then this task is conceptually straightforward—but the demand functions are typically not known. However, Diewert (1976) showed that a class of "superlative" indexes existed which, under certain assumptions, could provide a close approximation to a cost-of-living index, reflecting the effect of consumer substitution behavior. Knowledge of specific demand functions was not required. These superlative indexes have the common feature that they involve some form of symmetric averaging and a weighting system that utilizes quantity or expenditure data from both the reference (beginning) and comparison (ending) periods covered by the index. One well known superlative index is the Fisher index, which is calculated as the geometric mean of the Laspeyres and Paasche indexes. Another form of the superlative is the Tornqvist index, the geometric mean of the ratios of prices in the comparison and reference periods weighted by the average expenditure shares of the two periods. The Consumer Price Index is built up in layers. At the lowest level, prices of individual items are collected and assigned to some 200-plus categories of goods and services, called "strata"—major appliances, televisions, household cleaning products and such. A price index is calculated for each strata. In turn the strata price indexes are combined into indexes for major expenditure categories—like food, apparel and housing—and finally into the overall consumer price index. In 1999, the Bureau of Labor Statistics began to use geometric aggregation of the prices of individual items to calculate about 60 percent of the 200–plus strata price indexes, as a way of approximately taking into account the effect of substitution behavior within those strata. In July 2002, the BLS began to publish a supplemental CPI that aggregated those strata indexes into an overall index using a Tornqvist superlative index technique. However, superlative indexes face some practical difficulties and theoretical concerns.

A superlative index requires knowledge of consumer expenditure weights in both the reference and comparison periods. But acquiring information about current consumption is infeasible under current

BLS data collection techniques, which rely upon consumer surveys for detailed expenditure data to use as weights. As a result, the final version of the BLS superlative index is only available after a two-year lag. {*The Bureau of Labor Statistics has labeled the new supplemental index the C-CPI-U, the Chained Consumer Price Index for All Urban Consumers. While that index is available in its final version only after a two-year lag, the BLS will publish initial estimates of the index in real time and preliminary estimates with a one-year lag.}* Conceptually, the accuracy of the superlative in measuring the change in expenditures that is required to maintain a pre-specified standard of living (usually that of the reference period) depends on several factors. If preferences are stable and also homothetic—that is, as income changes, consumers scale their purchases up or down proportionately—all changes in relative quantity weights between reference and comparison periods are due to substitution behavior in response to relative price changes. Only with homothetic preferences will the change in the cost of living brought about by a change in prices be independent of the standard of living or utility at which it is evaluated. But the empirical evidence (via estimates of Engel curves) shows that preferences are not homothetic; relative demands for goods vary as income and living standards change. In that case there are different cost-of-living indexes at different standards of living. And then as Diewert (2000) has shown, when the standard of living in the reference period is different from that of the comparison period, the superlative will measure a cost-of-living index that maintains a standard of living at some level intermediate between the two.5 The same pattern of absolute and relative price changes can thus produce different superlative indexes depending on what happens to income and the standard of living over the period.

A similar result occurs when there are changes between the reference and comparison periods in one or more outside conditions, such as environmental pollution, the climate, the crime rate, and the provision of public goods. Such changes can alter consumers' preferences among market goods and services. For example, colder winters increase the demand for fuel oil, and higher crime rates raise purchases of home security systems and may lower the demand for downtown restaurant meals. In this situation, the superlative will again produce a cost-of-living index that maintains a standard of living somewhere between the reference and comparison period. Of course, tastes can change for other reasons as well. Thus, to the extent that income and preferences among market goods change between the two periods, a superlative index loses some of its accuracy as a measure of the cost of maintaining the reference period's standard of living. The bottom line is that an assessment of how accurately a superlative index will in practice capture the effects of consumer substitution behavior depends heavily upon a judgment about the extent to which changes in the pattern of quantities purchased are driven by changes in income and tastes or by substitution responses to changes in relative prices.

The Substitution Issue and the Debate over a Cost-of-Living Index: The panel's discussion of superlative indexes as a way to address substitution problems illustrated a dynamic that emerged a number of times. Even when panel members disagreed on their overall evaluation of pursuing a cost-of-living index as *Diewert (1976, Theorem 2.16) had earlier shown that, at least with translog utility functions, this intermediate standard of living will equal the geometric mean of the standards prevailing in the reference and comparison periods.* The Consumer Price Index: Conceptual Issues and Practical Suggestions 7 as an objective for the Consumer Price Index, they found that they could still come to unanimous agreement about specific recommendations—albeit for different reasons. For example,

those who supported the notion that the Consumer Price Index should be designed as a cost-of-living index saw the use of superlative indexes as a step toward this goal. But even members who had reservations about the feasibility of the broad task of measuring the cost-of-living agreed that household substitution behavior moderated the effect of changes in prices on consumer welfare, and that the weighting and aggregation procedure in the superlative index would typically move the CPI in the right direction. Hence, when considering the appropriate index to use in "compensating" Social Security or other income recipients for the effects of price changes, those members joined the others in recommending that the Bureau of Labor Statistics publish a superlative index and that it be used as the basis for compensation payments.

The Appropriate Domain of the Consumer Price Index: The Consumer Price Index has always been confined to the universe of market goods and services. Consumers' standards of living, however, are affected by a wide range of other developments in the physical, social and economic environment, such as changes in the crime rate or the extent of environmental pollution. The panel concluded that restriction of the CPI domain to market goods and services was appropriate and desirable. Even though changes in outside conditions can affect consumers' living standards, a cost-of-living index can be defined that excludes those effects. The result is a "conditional" cost-of-living index, defined as the minimum expenditure ratio necessary to maintain a given standard of living in the face of changes in the prices of market goods and services, when the status of the excluded outside conditions remains unchanged. Expanding the current universe of goods covered by the Consumer Price Index to include the effect on living standards arising from changes in outside conditions, including the benefits from the provision of public goods, would require analytical and measurement techniques that go well beyond the current state of the art. Some people have, nevertheless, argued that the BLS should undertake a long-range program of research to measure the effects on living costs from at least some of these outside conditions for the purpose of eventually including them in a cost-of-living index. The panel offered two responses to this point of view. First, even if reliable estimating techniques could be developed, a broader definition of a change in the cost of living would not be appropriate for most of the major uses to which the Consumer Price Index is currently put. Second, while additional research on the measurement of a broad standard of living is indeed worth pursuing, such a research effort should be part of a program to produce experimental "satellite accounts" that can supplement the current national income and product accounts. Any research program aimed at exploring the effects of changes in outside conditions on consumer welfare should be carried out as part of this effort.

Particular Uses of the Consumer Price Index: The Consumer Price Index has a number of particular uses. It provides an overall measure of consumer goods inflation. In that role, it is used for indexing Social Security and other public benefits, as well as income tax brackets, against inflation. It also serves as an indicator for monetary policy. For these particular uses, a broad cost-of-living index that includes changes in living standards resulting from factors like decreases in crime or increases in traffic congestion does not seem appropriate. By tying Social Security benefits and certain transfers to the poor and disabled to a price index, the Congress (perhaps without full awareness of the fact) did insulate the income of beneficiaries from many positive and negative supply shocks that affect the real wages of the working population, such as changes in productivity and fluctuations in the prices of oil and foreign

exchange. But it is hard to believe that there would be significant public support to go well beyond that, distinguishing beneficiaries from other consumers by compensating or penalizing them for beneficial or harmful changes in, say, environmental pollution, the crime rate or the climate. In the case of inflation, its economic costs all invoke some aspect of its monetary nature and its relationship to market transactions, like the effect of high and variable inflation in raising the risks associated with forward commitments and decreasing the efficiency of forward planning or the effects of inflation in producing unintended increases in marginal tax rates. There is, therefore, no reason we should want the Federal Reserve to tighten monetary conditions to produce deflation in the prices of market goods in an effort to offset the effects on an unconditional cost-of-living index from a worsening in the crime rate or an increase in congestion. Of course the Federal Reserve could, and surely would, strip out the environmental factors from an unconditional price index and look only at the changes in market prices in making its decisions about monetary policy. But that is simply a confirmation of one more use of the Consumer Price Index that would not be met by an unconditional cost-of-living index.

Satellite Accounts: While the members of the panel agreed that the Consumer Price Index should continue to be confined to the domain of private goods and services, we also recognized the potential usefulness of a research program aimed at supplementing the official measures of national output, income and prices with experimental estimates of the effect of various outside conditions on the material well-being of the population. But we concluded that this task should not be undertaken by the Bureau of Labor Statistics on its own, with the aim of producing a more comprehensively defined cost-of-living index. Rather, it should be pursued through the development of experimental measures of expanded national output and income within an integrated national accounting framework. The reason is that such estimates will typically involve quite different types of analysis and estimation than that associated with the estimation of a cost-of-goods index or a cost-of-living index restricted to the domain of market goods.

For example, the real output of private goods and services is seldom measured by collecting data on physical quantities. Rather, observed nominal expenditure data—for example, the consumption components of the GDP—are deflated with appropriate price indexes (principally the components of the CPI) based on observed market prices, quality adjusted to the extent feasible. But in the case of outside goods, there are no nominal expenditure data to be deflated. Changes in both the "output" and the implicit "prices" of such goods, and in the changes of output and price, have to be estimated independently of each other. This task is especially complex because an important fraction of the "goods" (or "bads") currently excluded from the domain of the Consumer Price Index are intermediate goods, like public highways, the effects of acid rain on building materials and the economic costs of business crime. But the effects of changes in the quantity of such intermediate goods on private costs and prices are already reflected to some extent in the CPI and the value of private output.

To avoid double counting, an accurate accounting of these goods and bads in a broad standard of living calculation would require that the intermediate effects be identified and excluded from measures of final consumption output and prices. This task would require a set of consistent national accounts within which to make the estimates. In sum, research efforts aimed at estimating the effect of selected environmental changes on the nation's economic welfare must be imbedded in a consistent accounting

framework that takes account of stocks and flows, output quantities and prices, and distinguishes intermediate from final goods. In the panel's view, this task is not a job to be carried out by the Bureau of Labor Statistics on its own with the aim of significantly broadening the domain of the Consumer Price Index. Some Complications Created by a Conditional Cost-of-Living Index.

Some Complications Created by a Conditional Cost-of-Living Index: All of the members of the panel agreed that the domain of the Consumer Price Index ought to be restricted to the universe of private goods and services. But the advocates of a cost-of-goods index argued that such a restriction raised difficulties for a cost-of-living framework. While an index can be constructed that ignores the direct effects of changes in the environmental factors we want to exclude—for example, the increased insecurity from a rise in the crime rate or any discomfort from a cold winter—changes in outside conditions can sometimes alter the demand pattern among private goods; for example, with a higher crime rate, purchases of downtown restaurant meals may fall while the demand for home security systems rises, and a cold winter raises the demand for heating oil. As a result, the superlative index, which in practice is how we measure a cost-of-living index, will reflect the effects on quantities of private goods purchased induced by changes in outside conditions as well as those made in response to changes in relative prices. The pragmatic question, again, is the extent to which such factors reduce the Journal of Economic Perspectives accuracy with which the superlative index measures the conditional cost-of-living index that we want.

Specifying that the conditional cost-of-living index be limited to the universe of private goods and services does not automatically provide answers to another difficult set of questions in index design. For example, how comprehensively should we include the effects of changing technology on the standard of living? Arguably, we may want to allow the conditional cost-of-living index to be quality adjusted to reflect estimates of the welfare effects of improvements in identifiable medical procedures that reduce mortality and morbidity. But would we want to include in the cost-of-living index the effects of increases in longevity associated with broad and widely diffused changes in economic conditions and human knowledge like better sanitation, changes in dietary habits, or a higher standard of scientific knowledge? Similarly, how should we treat consumer benefits from the increased networking of information technology?

Because of considerations like these, some members of the panel concluded that conditional cost-of-living indexes are not well-defined because we have no theoretical procedures for deciding whether a particular quality change should be treated as a price change or as an "outside" factor to be conditioned out. On the other hand, other members concluded that such decisions have to be made on the basis of considering the purposes for which the index is to be used (in addition, of course, to measurement feasibility). As I noted earlier, the decision to restrict the conditional cost-of-living index to the domain of private goods and services stems from the need for an index that can be used, among other purposes, to measure inflation, compensate pensioners and index the tax code. Given that decision, the choice about how to treat advances in technology and human knowledge revolves importantly around whether those changes produce specific and measurable quality improvements in one or more private goods and services. While many social and environmental developments have broad effects on the well-being of households— for example, better dietary habits improve longevity—they would not be relevant for

inclusion in the domain of a conditional cost-of-living index designed for the purposes mentioned above. And so, according to the supporters of the cost-of-living concept, the fact that the basis for such domain decisions cannot be provided from within the general theory underlying that concept is not a reason to preclude using the conditional cost-of-living index as the framework for the design and construction of the Consumer Price Index.

Quality Change: Given the magnitude of the potential effects of quality changes on consumers' living standards, and the progress that has been made in addressing the substitution issue, the most important challenge facing the Bureau of Labor Statistics at the present time is how to deal with quality changes. The problem with the traditional approach to dealing with quality change in the Consumer Price Index is not that the BLS fails to make adjustments for such changes. In fact it does, and quite frequently. Rather, the problem is that the traditional techniques for adjustment may often mismeasure the effect of the quality changes on the price index.

The Traditional Approach to Quality Change: For decades, the Bureau of Labor Statistics has made two types of implicit quality adjustments: within-sample item replacement and sample rotation.

The process of within-sample item replacement arises because some 30 percent of the sample of items whose prices the BLS has been collecting as part of constructing the Consumer Price Index disappear from store shelves each year due to natural attrition. As a consequence, other items must be substituted. When a sampled item can no longer be found at a retail outlet, the BLS price agents are instructed to select the most similar replacement available within the store. In about two-thirds of the replacements, BLS commodity specialists judge the chosen substitutes "comparable"; they resemble the old good sufficiently so as to be treated the same for purposes of pricing. But one-third of the replacements are classified as "non-comparable"—sufficiently altered that some of the difference between the price of the old and the new good must be attributed to quality differences. In almost all such cases, BLS procedures have assumed that in the month of its introduction into the index, the "pure" price of the new good has risen by the same amount as the average price rise for similar goods. Any remaining difference between its stated price and the price of the good it replaces is therefore assumed to represent a difference in quality and is not counted as a price change.

In addition to the replacement of items that disappear from its current sample through attrition, the Bureau of Labor Statistics also rotates the overall sample; on average, about 25 percent of the BLS sample of items sold in retail outlets is replaced when new stores are rotated into the sample each year. Within each category of goods, the particular models or varieties to be priced in the newly sampled stores are selected to reflect current sales patterns. Since, on average, four years elapse before particular stores and items are replaced, the new sample will contain many items whose characteristics and features are different from those in the old sample. Price indexes for the new sample of stores and items are linked to those of the outgoing sample during an overlap period on the assumption that any contemporaneous differences in the prices of items are assumed to reflect differences in quality and do not enter the index as price changes.

These traditional methodologies for within-sample item substitution and for sample rotation can potentially mismeasure quality change in two important ways. First, as noted above, the quality difference between products with different characteristics is assumed to be exactly equal to their price difference. But when new varieties of products are introduced whose prices, after allowance for their improved quality to consumers, are lower than the prices of older varieties, this approach is likely to understate the value of the improvement and impart an upward bias to the index (Triplett, 2001, chapter 4). The very fact that newer varieties of items have displaced the ones that disappeared creates the presumption 12 Journal of Economic Perspectives that consumers have found these items to be cheaper, on a quality-adjusted basis, than those that disappeared.6 In other cases, especially where fashion and fads play a large role, sellers apparently often use the occasion of introducing new models to raise prices on those models. Relative prices then gradually fall until another round of introduction occurs. Here, the current linking technique, which imputes the pure price change in a new model from the changes in prices of the older models, can understate that price change, overstate the implicit quality adjustment and tend to create a downward bias in the index.

2.1.1 Hedonic Techniques

Hedonic techniques employ the assumptions that what consumers' value in a good is the set of characteristics that the good possesses and that the analyst can identify and quantify those characteristics. Some examples include the following: screen size and surround sound in TV sets; speed, bytes of random access memory and hard drive capacity in computers; and type of fabric in a dress. In each of these products, the list of relevant and measurable characteristics is, of course, much larger than these few examples. By regressing the prices of different models of a product on measures of their characteristics, one obtains a relationship that explains the price of a product as a function of its characteristics.

Hedonic techniques can be used to make quality adjustments in the Consumer Price Index in one of two ways. First, in what is called the "indirect" approach, a hedonic equation can be fit over a cross-section of the different models or varieties of a particular product during some recent time period. Subsequently, when a non-comparable item is chosen as a substitute for one that has disappeared, the market value of differences in particular characteristics between the old and the new variety can be calculated from the coefficients of the regression and subtracted from the "raw" price change, leaving the residual as the "pure" price change. This indirect approach is the one currently used by the BLS for the hedonic applications it has incorporated into the construction of the CPI.

The alternative and more ambitious "direct" approach essentially treats the price of each variety of a line of products as an aggregate of the prices of its characteristics that are given by the coefficients in the hedonic regression.8 To produce a monthly index for a given product with a number of quality-differentiated varieties, a hedonic equation is estimated each period. The reference and comparison period coefficients (the implicit prices of the various characteristics) are each weighted by the aggregate quantities of the characteristics of the items in the [*See Pakes (2002, pp. 4–5). However, the statement in the text needs to be qualified. Some minority fraction of consumers may still have preferred the older good that disappeared and have been willing to pay at or above the unit costs of producing them at the*

old volume, but the reduced volume wasn't large enough to cover the fixed costs of continuing their production. For some quantitative analyses of this phenomenon, see Moulton and Moses (1998) and Triplett (1997). There are several variations of the direct approach, but for purposes of this discussion, I have concentrated on the one described in the text. Charles L.] reference period and then averaged. The ratio of the two averages produces a quality-adjusted index for the product line. However, the refitting, review and application of hedonic equations each month for timely incorporation into that month's Consumer Price Index would impose stringent requirements on the data collection and operating system of the Bureau of Labor Statistics.

The Use of Hedonics by the Bureau of Labor Statistics: In 1990, the Bureau of Labor Statistics began employing hedonics in the apparel sector and, in 1999, incorporated hedonic equations for computer item substitutions, based on research done for the Producer Price Index.10 Several years ago, the BLS developed and introduced into the index indirect hedonic methods for pricing non-comparable substitutions among ten additional products. Nine of these additional products were appliances or electronic products: televisions, VCRs, audio products, camcorders, microwave ovens, refrigerators, clothes dryers, washing machines, and DVD players. The tenth was a subject of particular interest to academics—namely, college textbooks.

For eight of the ten products for which hedonic adjustments were recently introduced, the BLS generated two versions of the various strata indexes within which those products were located, one constructed with the traditional approach and the other with hedonic quality adjustment. In most cases, expenditures on the products to which hedonics were applied represented only a fraction of the total expenditures in the relevant CPI strata. In only three of the eight cases did the use of hedonic techniques make more than a small difference in the rate of price change in the relevant strata indexes during the period of comparison, and in two of those cases the hedonically adjusted indexes showed a smaller rate of price decline than did the published indexes. The switch to hedonic adjustments did produce more substantial differences in the rate of price change for the replacement items themselves. Calculations of the effect on the price changes of replacement items from the use of hedonic quality adjustments in place of the traditional approach were published for only five of the ten products.

The differences were positive on average for some of these products and negative for others, and on an unweight basis, they roughly canceled out across all the products. All in all, the introduction of these hedonic adjustments had little impact on the Consumer Price Index. [Pakes (2002) has suggested an alternative approach that would preserve the basic elements of the direct hedonic methodology while easing somewhat the burden on the Bureau of Labor Statistics (it would no longer be necessary to fit the hedonic equation in current (comparison) month). Since 1988, the Bureau of Labor Statistics has used a restrictive type of hedonics to adjust contract and owner equivalent rent for the effect of aging in housing units. Reports on eight hedonic studies can be obtained from the Bureau of Labor Statistics website: http://www.bls.gov/cpi/#publications.The television study is reported in Moulton, LaFleur and Moses (1998). For a more detailed analysis of the recent hedonics studies done by the Bureau of Labor Statistics, see Schultze and Mackie (2002)][14].

The television hedonic study, like many of the others, produced no significant difference from the traditional approach when it was applied only for item replacements. But in this study a direct hedonic approach was also employed, which generated an index of the quality-adjusted prices of all televisions in the sample, not just item replacements. Over the period 1993 to 1997, that index fell by 1.5 to 2.0 percent a year faster than the traditionally constructed index (with the range arising from the use of alternative base periods and weights). The authors of the television study suggest two possible reasons, both of which may have played some role. First, the direct estimation approach captures the effects of the large number of quality changes picked up during sample rotation, which are missed when only item replacements are hedonically adjusted. Second, the item replacement process is highly conservative, in that it calls for the selection of the replacement that is most similar to the item that disappeared (Moulton, LaFleur and Moses, 1997). One obsolete model is often replaced by another nearly as obsolete, which minimizes the selection of replacements nearer the cutting edge of technological advance where new models are more likely to enter at quality-adjusted prices lower than old models. Similarly, in markets where sellers use the occasion of introducing a new style to raise prices, the most similar replacement is less likely to be one of the new styles.

Concerns About the Current Hedonic Methodology: The panel concluded that even a substantially expanded use of hedonic techniques, if restricted to the current item replacement process, would be unlikely to have a significant effect on the Consumer Price Index. However, if as Moulton, LaFleur and Moses (1997) have suggested, out-of-date items were replaced by those that more nearly reflected changes in consumer buying patterns occurring since the last sample rotation, or if hedonic techniques were applied to quality changes occurring in sample rotation, then the fraction of price quotes receiving explicit and significant quality adjustments would expand substantially, which in turn would importantly increase the potential for the application of hedonic techniques to have an effect on strata indexes.

However, the panel's review of the application of hedonic models in the Consumer Price Index also raised a number of substantive questions about how the technique is currently being applied, including issues about the identification of characteristics, model stability and econometric specification. We concluded that these issues require a good bit of additional research and experimentation before hedonic techniques are further integrated into the CPI and the scope for their application substantially expanded. The reasons for our concern are spelled out in the body of the panel's report (chapter 4, especially pp. 132–145), but a few examples can give some flavor of their content. A principal issue is the stability of the hedonic regression coefficients. Remember that in the indirect method, a hedonic equation is fit over a cross-section of the varieties of a product, and the resultant coefficients are used unchanged in subsequent periods to adjust item substitutions.

Hedonic equations for computers are now refit three or four times a year, because research has shown that the coefficients in such equations can change frequently. But such frequent refitting is exceptional. At least part of the reason is constraints on budget and personnel resources. In seven of the ten hedonic equations discussed above, the current BLS sample size had to be substantially expanded—on average by a factor of three—to obtain reasonably reliable estimates. Also, re-specifying the hedonic models and reviewing the results is labor intensive, while the BLS has other research priorities to meet. Whatever the reasons, the Bureau of Labor Statistics, as of October 2002, had only refit equations for three of the

ten other products (VCRs, DVD players and televisions), had not refit the remaining equations since they were developed, was considering again refitting the television equation, but otherwise had no current plans or schedule to refit the other equations in the near future.

Ariel Pakes (2002) has argued, convincingly I believe, that at least for some products, rapid technological advance and changes in markups and development strategies among imperfectly competitive firms should be expected to produce changes over time in the hedonic coefficients. Under the indirect approach, with infrequently refit equations, the issue of coefficient stability becomes particularly important. It seems reasonable that the variance over time in hedonic coefficients for a product will depend importantly on the pace of technological advance and on market structure. The individual characteristics of some products may have reasonably stable coefficients over substantial time periods, others not. The key question is which is which. The use of brand names as characteristics in hedonic regressions raises some important issues. In almost all of the ten hedonic studies recently carried out by the Bureau of Labor Statistics, the regression equation included indicator variables for the brand name of the model. One rationale for the inclusion of brand name is that is serves as a proxy for unobserved qualities, such as quality of service or frequency of repair. But this assumption is not always warranted. In one case—microwave ovens—the study reported that brand coefficients were inversely correlated with Consumer Reports rankings for low repair frequency (Liegey, 2000, p. 5). When the correlation between a brand and other important included or excluded characteristics alters, application of an unchanged brand coefficient is likely to yield "wrong" quality adjustments. In this respect, the use of brand names coefficients in the indirect hedonic approach is simply a special example of the coefficient stability problem discussed above.

Panel's Recommendations on Hedonics: In recent months, a number of the panel members have heard comments to the effect that the panel's report takes a negative view about the potential of hedonic techniques—apparently because the report discusses some of the difficulties with hedonic techniques. Yet our report explicitly concluded: "Hedonics currently offers the most promising technique for explicitly adjusting observed prices to account for changing product quality."

The issue is not whether hedonics is potentially of great usefulness. It is. Rather, what is at stake is essentially a choice between two different ways the Bureau of Labor Statistics could employ its hedonics R&D budget in the near-term future. The BLS could devote the bulk of those resources toward developing a steady stream of hedonic equations and incorporating them into the estimation of the Consumer Price Index. But the panel's analysis suggests that under current operating procedures, the results would not be likely to have much effect on the index. Alternatively, it could, as the panel suggests, channel its efforts principally into analyses, tests and experiments aimed at exploring and resolving some of the methodological issues discussed in the panel's report. The results might well justify the modification of BLS item replacement procedures and an expanded application of hedonics in a way that could make important improvements in the index.

Going beyond the content of the panel's report, my own view is that the research program, among many other goals, could investigate the question of whether evidence about the pace of technological advance or the market structure of the industry could be used to predict the degree of coefficient

stability. With some experimentation, it might also be possible to design a regime under which newly developed hedonic equations would initially be refit at short intervals and the results used to help determine the appropriate frequency of future refitting. To the extent that, with sufficient research and experimentation, the Bureau of Labor Statistics can identify products that are likely to have relatively stable hedonic coefficients, the current methodology of indirect hedonics can be applied and expanded with infrequent refitting and reasonable cost. I suspect, however, that the application of hedonic methodology to sample rotation would require the use of direct hedonic methodology, which in turn involves continuous refitting of the equations. The panel recommended that the BLS experiment with the direct method, beginning with a few carefully selected goods.

As explained earlier, fitting hedonic equations typically requires the expansion of the current sample of prices collected by the Bureau of Labor Statistics or the purchase of privately collected data. Under current data collection methodology, frequent refitting and, even more so, the continuous refitting required by the direct method could become very costly. This in turn suggests that research on lowering the costs of data collection through the use of scanners, and perhaps other techniques, could eventually play an important role in enlarging the scope for hedonic methods within the Consumer Price Index.

Cost-of-Living Theory and Hedonic Techniques: One of the most widely cited advantages of cost-of-living theory is its usefulness in dealing with quality changes. It naturally prompts the question "what are the attributes of a good that consumers value" and looks for answers to the standard economic theory of consumption, which tells us that information about relative values can be inferred from their relative prices. But a closer look at the problem of measuring the effect of quality changes with hedonic techniques suggests that the application of the theory to specific issues of quality adjustment is far from straightforward.

The hedonic coefficients on the characteristics of goods are used to impute a monetary value to the quality difference between two goods on the basis of the differences in their characteristics. In the standard economic theory of consumption, all consumers face the same prices for each good and adjust their purchases accordingly so that the ratios of prices equal their marginal rates of substitution. Price ratios are thus assumed to represent ratios of marginal values received. But in different varieties of a particular good, various attributes or characteristics are combined in a limited number of discrete packages, and hedonic functions are not generally linear. In equilibrium, consumers with different preferences will end up facing different prices for characteristics. Indeed, without this heterogeneity of preferences, individuals at the same living standards would all tend to buy the same variety of a good; all $25,000 automobiles would be the same. One consequence is that changes in income distribution and the demographic mix of consumers can shift the relative market prices of characteristics without any quality changes. The heterogeneity of consumer preferences over the various characteristics of a good, combined with the other aspects of quality comparisons described above, make it difficult to infer welfare interpretations from the properties of hedonic equations.

Zvi Griliches, one of the pioneers in applying hedonics to price index construction, commented in 1976—and cited the comment approvingly 14 years later (Griliches, 1990, p. 189, emphasis supplied): What the hedonic approach attempted was to provide a tool for estimating "missing" prices, prices of bundles not

observed in the original or later periods. It did not pretend to dispose of the question of whether the various observed differentials are demand or supply oriented, how the observed variety of models in the market is generated, and whether the resulting indexes have an *unambiguous welfare interpretation.* All the members of the panel agreed that hedonic regressions should be looked upon essentially as devices to estimate the market prices of alternative bundles of characteristics of goods and that hedonics can be applied within either a cost-of goods or a cost-of-living index framework. Again, the panel's recommendations on hedonics represent another example in which differences of views about the relative merits of the two index concepts did not prevent agreement about a set of specific recommendations to the Bureau of Labor Statistics.

2.1.2 Dealing with the Introduction of New Goods

The methodology of the Bureau of Labor Statistics does not reflect the gain in consumer welfare (the compensating variation or the consumer surplus) that a when new goods are introduced and gain a place in the market. This gain in consumer welfare is measured by the area under the Hicksian compensated demand curve above the current price, and for the consumers purchasing the product; this gain represents a decrease in the cost of living (Hausman, 1997).

To measure the welfare gain from the introduction of a new product, it is necessary to collect in each period data on quantities purchased and to estimate the demand curve for the new product and its "virtual price"—the price sufficiently high to reduce the quantity demanded to zero. A priori, one might expect that only new goods that provide radically improved capabilities would generate significant consumer surpluses. But in a well-known paper, Hausman (1997) estimated a demand curve for what would seem to be a modestly differentiated new variety of Cheerios breakfast cereal—Apple Cinnamon Cheerios—and calculated that its introduction generated substantial additions to consumer welfare. In his companion article in this issue, Hausman argues that the Bureau of Labor Statistics should not only calculate and adjust the Consumer Price Index for the introduction of completely new goods, but that current approaches for dealing with quality change, including the use of hedonic techniques, should be replaced by estimates of the corresponding compensating variations.

The panel recognized that research into the welfare effects associated with new goods is important and should be pursued. But it emphasized the immense practical difficulties in the way of providing estimates of demand curves and virtual prices, especially if done across the large number and wide variety of products that would be required if this methodology were to supplant current methods of adjusting for quality change. In particular, estimating these welfare effects would impose the difficult requirement that the supply and demand factors that interact to generate prices and qualities be disentangled to identify the demand curve itself. Which assumption is chosen for identification purposes, among several competing possibilities, can often make a substantial difference in results. Thus, Hausman's (1997) estimate of the demand elasticity for Apple Cinnamon Cheerios has been disputed on grounds that a key assumption used in identifying the demand curve was open to serious question (Bresnahan, 1997).

Knowledge about the desirability of most new products diffuses gradually throughout the economy, so that the demand curve is, for a while, shifting rightward. Where fads or fashions play an important role, the demand curves for a new variety may first rise and then recede; consumer surpluses appear and then fade. To capture continuing changes in demand, the demand curve for new products and [*In both his cell phone and cereal studies, Hausman (1997,1999) suggests that to avoid the uncertainties of extrapolating the "true" demand curve backward, outside the limits of observed data one could calculate a conservative lower bound estimate by extending back a tangent to the demand curve from the observed price and quantity. 14 As pointed out earlier, hedonic equations are designed to estimate the market prices of bundles of characteristics. They do not depend on identifying the demand and supply factors underling price changes and hence generally pose much less rigorous econometric requirements.*] varieties must be continuously re-estimated, and the forces affecting supply and demand continuously disentangled.

There is an important potential in using scanner data, as well as other commercial electronic databases, to collect real time price and quantity data that could assist in studying new goods. At the same time, however there are substantial practical and conceptual challenges that would have to be overcome to incorporate widespread use of scanner data in the CPI. The panel's report discusses both the possibilities and the challenges and identifies a number of areas that ought to receive high priority for research and experimentation.

The National Academy of Sciences panel concluded that it is unlikely a consensus methodology for producing reliable estimates of demand curves and virtual prices will emerge in the near future. It is impossible for the Bureau of Labor Statistics to attempt to incorporate into the Consumer Price Index measures of the welfare gain from the introduction of new goods or new varieties of existing goods with the economic and statistical techniques available at this time. Some panel members believed that even if reliable estimating methodology were available, the welfare gains from the introduction of new goods should not be treated as equivalent to a price reduction in the CPI. But recognizing that there are no measures of national output growth available that reflect the welfare gains from those events, the panel agreed that research in this area, while not designed to replace the CPI, should be directed toward developing, to the extent feasible, a separate experimental index that did account for such gains. With

All Deliberate Speed: Important progress has been made during recent years in improving the Consumer Price Index, especially from the standpoint of those who favor moving it closer to a cost-of-living index. The potential exists for still further significant progress. But in the process of trying to realize improvements, it is essential to avoid the temptation of moving rapidly to expand the use of potentially valuable techniques before their application across a wide range of areas has been sufficiently developed and tested. This reasoning underlay the panel's recommendation that research be undertaken to deal with some important methodological problems in the current application of indirect hedonic techniques, not least the issue of coefficient stability, before further major integration of hedonics into the CPI. As one part of that effort, research and experimentation on data collection techniques might make feasible more frequent refitting of hedonic equations where that proves to be necessary, as well as a wider use of direct hedonic techniques.

It is also important that in moving the Consumer Price Index closer toward a [*A useful discussion of the promise and the difficulties of using scanner data for the CPI is contained in the NBER Conference volume, Scanner Data and Price Indexes (2000).*] cost-of-living index, we remember that for the major purposes to which we put the CPI, it must remain grounded on the underlying concept of measuring the change in expenditures needed for a consumer to maintain a given standard of living in the face of changes in the prices of market goods, conditioned on stability in the status of conditions outside the market that affect consumers' living standards. The panel recognized that one of the important tasks for research in the area of economic measurement is the conceptual design and practical implementation of experimental measures of selected outside conditions. However, we agreed that the development and improvement of a cost-of-living index is not suitable vehicle into which to cram research about these matters.

In a similar vein, the current level of uncertainty about the accuracy and reliability of available techniques for estimating virtual prices strongly argues that the Bureau of Labor Statistics should not attempt to adjust the Consumer Price Index to take account of such effects. But that does not preclude undertaking research aimed at improving our ability to develop experimental measures of national output growth that take account of the welfare-enhancing effects stemming from the introduction of new goods. * *The author thanks Katharine Abraham, Angus Deaton, Erwin Diewert, Christopher Mackie, Van Doorn Ooms, Richard Schmalensee and Jack Triplett for their valuable comments and suggestions. The editors of this journal improved the initial draft and contributed not only in style and organization, but also on matters of substance.*

2.2 CPI concepts and scope

The CPI provides an estimate of the price change between any two periods. The CPI follows the prices of a sample of [[2] *Until 1982, BLS maintained separate (but overlapping) samples of outlets and specific items for the CPI-U and CPI-W populations. Given little variance in the movements between the CPI-U and CPI-W, BLS dropped the separate samples for the CPI-W population. The CPI-U converted to rental equivalence effective with the indexes for January 1983; the CPI-W moved to rental equivalence 2 years later. Since January 1985, the movements of all CPI-W basic indexes have been identical to those of the CPI-U.]* Items in various categories of consumer spending—such as food, clothing, shelter, and medical services—that people buy for day-to-day living. The monthly movement in the CPI derives from weighted averages of the price changes of the items in its sample. A sample item's price change is the ratio of its price at the current time to its price in a previous time. A sample item's weight in this average is the share of total consumer spending that it represents. The algebraic formulas used for this averaging are called index number formulas.

A unifying framework for dealing with practical questions that arise in the construction of the CPI is provided by the concept of the cost-of-living index (COLI)4. As it pertains to the CPI, the COLI for the current month is based on the answer to the following question: "What is the cost, at this month's market prices, of achieving the standard of living actually attained in the base period?" This cost is a hypothetical expenditure—the lowest expenditure level necessary at this month's prices to achieve the base-period's living standard. The ratio of this hypothetical cost to the actual cost of the base-period

consumption basket in the base period is the COLI. Unfortunately, because the cost of achieving a living standard cannot be observed directly, in operational terms a COLI can only be approximated. Although the CPI cannot be said to equal a cost-of-living index, the concept of the COLI provides the CPI's measurement objective and is the standard by which we define any bias in the CPI. BLS long has said that it operates within a cost-of-living framework in producing the CPI. That framework has guided, and will continue to guide, operational decisions about the construction of the index.

Because the COLI is not directly observable, the CPI employs index number formulas that offer approximations to the measurement objective. The CPI-U and the CPI-W use a Laspeyres formula to average the price changes across categories of items. It is sometimes said that the Laspeyres formula provides an "upper bound" on the COLI index. The C-CPI-U uses a Törnqvist formula to average price changes across item categories. This formula belongs to a class of formulas called superlative because, under certain assumptions, they can provide close approximations to a COLI. Since 1999, the CPI program has used the geometric mean formula to average price change within most item categories. Under certain assumptions that are likely to be true within most categories, an index based on the geometric mean formula will be closer to a COLI than will a Laspeyres index. [*For a review of index number formulas, their properties, and their relationship to economic theory, see W. E. Diewert, "Index numbers," in J. Eatwell, M. Malgate, and P. Newman eds., The new Palgrave: a dictionary of economics, vol. 2 (London: The MacMillan Press, 1987), pp. 767–780. 4 For more information on the cost-of-living index concept, see the technical references at the end of this chapter. 5 On the use of a cost-of-living index as a conceptual framework for practical decision making in putting together a price index, see Robert Gillingham, "A conceptual framework for the revised Consumer Price Index." Proceedings of the American Statistical Association, Business and Economic Statistics Section (Alexandria: VA, American Statistical Association, 1974), pp. 46–52.*]

Scope The cost of maintaining a standard of living is affected by phenomena that go beyond the traditional domain of a consumer price index—changes in the cost of consumer goods and services. The broadest form of a COLI, which is called an unconditional COLI, would reflect changes in non-price factors such as crime rates, weather conditions, and health status. The objective of the CPI, by contrast, is to provide an approximation to a conditional COLI that includes only the prices of market goods and services or government provided goods for which explicit user charges are assessed. Free goods, characteristics of the environment (such as air and water quality), the value of leisure time, and items that governments provide at no cost are not in scope, although they undeniably can have an impact on the cost of living as broadly defined.

Excluded goods and services. The CPI covers the consumption sector of the U.S. economy. Consequently, it excludes investment items, such as stocks, bonds, real estate, and business expenses. Life insurance also is excluded for this reason, although health, household, and vehicle insurance are in scope. Employer provided in-kind benefits are viewed as part of income. Purchases of houses, antiques, and collectibles are viewed as investment expenditures and therefore excluded. Gambling losses, fines, cash gifts to individuals or charities, and child support and alimony payments also are out of scope. Changes in interest costs or interest rates are now excluded from the CPI scope, although some were in

the CPI for many years. And, for practical reasons, the CPI excludes illegal goods and services and the value of home-produced items other than owners' equivalent rent.

Taxes. Both the CPI and the conditional COLI measure changes in expenditures—including the effect of changes in sales taxes and similar taxes that are part of the final price of consumer products—needed to achieve the base-period standard of living. Neither the CPI nor the COLI, however, measures the change in before-tax income required to maintain the base-period living standard. For this reason, neither the COLI nor the CPI is affected by changes in income and other direct taxes. For certain purposes, one might want to define price indexes that include, rather than exclude, income taxes. The CPI does include the effects of changes in sales taxes and other indirect taxes. As previously noted, however, these are included as part of the price of consumer products. No attempt is made to reflect changes in the quantity or quality of government services paid for through taxes. [[6]*One could develop an index along these lines. Such an index (sometimes called a tax-and-price index) would provide an answer to a different question (along the lines of "At current prices, what is the least before-tax income needed to buy…") from the one that is relevant to the CPI. It would be appropriate for different uses. For a research measure of a consumption index inclusive of income taxes and Social Security contributions, see Robert Gillingham and John Greenlees, "The impact of direct taxes on the cost of living." Journal of Political Economy, August 1987, pp. 775–796.]*

Government-provided and government-subsidized items. The CPI treats as price changes any changes to fees that the government charges for items, such as admission to a national park. The CPI also counts the price of subsidized items that are available to the general public. For example, governments may subsidize local transit operation. If the subsidy is cut and the fare is raised, the CPI will reflect this price increase. On the other hand, the CPI does not reflect changes to means-tested (dependent on the recipient's income) subsidies, such as the Supplemental Nutrition Assistance Program or Section 8 housing allowances. Changes in such subsidies are treated as changes to the recipient's income and, therefore, out of scope.

2.2.1 CPI structure and publication

Calculation of price indexes In the CPI, the urban portion of the United States is divided into 38 geographic areas called index areas, and the set of all goods and services purchased by consumers is divided into 211 categories called item strata. This results in 8,018 (38 × 211) item–area combinations. The CPI is calculated in two stages. The first stage is the calculation of basic indexes, which show the average price change of the items within each of the 8,018 CPI item–area combinations. For example, the electricity index for the Boston CPI area is a basic index. The weights for the first stage come from the sampling frame for the category in the area. At the second stage, aggregate indexes are produced by averaging across subsets of the 8,018 CPI item–area combinations. The aggregate indexes are the higher level indexes; for example, the all-items index for Boston is an average of all of the area's 211 basic indexes. Similarly, the aggregate index for electricity is an average of the basic indexes for electricity in each of the 38 index areas. The U.S. city average All-items CPI is an average of all basic indexes. The weights for the second stage are derived from reported expenditures from the Consumer Expenditure Survey (CE).

CPI publication: Indexes. Each month's index value displays the average change in the prices of consumer goods and services since a base period, which currently is 1982–84 for most indexes. For example, the CPI-U for July 2013 was 233.596. One interpretation of this is that a representative set of consumer items that cost $100 in 1982–84 would have cost $233.60 in July 2013.

Percent change. Rather than emphasizing the level of the index in comparison to the base period, the monthly CPI release stresses the CPI's percent change from the previous month and from the previous year. The most commonly reported monthly percent changes are the one-month seasonally adjusted percent change, and the 12-month not seasonally 4 adjusted percent change. For example, the July 2013 CPI was 233.596 and the July 2012 CPI was 229.104, so the CPI increased 2.0 percent (not seasonally adjusted) from July 2012 to July 2013.

CPI area indexes and CPI item indexes. BLS publishes a large number of additional CPI index series. (See appendix 1.) For the CPI-U population areas—the broadest geographic coverage—detailed item indexes for most categories of consumer spending are published every month. Also every month, BLS publishes all-items indexes, along with a limited set of detailed indexes, for the three largest metropolitan areas and for the major geographic areas. In addition, detailed food, energy, and shelter indexes are published monthly for all CPI publication areas. Bimonthly or semiannually, all items indexes for selected metropolitan areas are published along with the limited set of detailed indexes. The primary reason for publishing CPI area-item detail indexes is to aid in analysis of movements in the national all items CPI. Decisions on which detailed indexes to publish depend, in part, on the reliability of their estimates. CPI area indexes and CPI item detail indexes use only a portion of the CPI sample; this makes them subject to substantially greater sampling error than the national CPI. **For this reason, BLS strongly urges users to consider the U.S. city average all items CPI for use in escalator clauses.**

CPI area indexes. BLS calculates and publishes separate area indexes for:

• Four geographic regions (sometimes called census regions): Northeast, Midwest, South, and West

• Three population-size classes: large metropolitan areas, small metropolitan areas,8 and nonmetropolitan urban places

• Selected region-size classes—regions cross-classified by population size (for example, large metropolitan areas in the Northeast)

• Selected metropolitan areas

Comparing the CPI for an area with the U.S. CPI or with the CPI for another area gives an indication of differences among the areas' rates of price change. In other words, such a comparison indicates whether, over time, prices of items that consumers in one area tend to buy have risen more or less rapidly than the prices of items that consumers in another area tend to buy. It does not indicate whether the average level of prices in an area is higher or lower than the average level in another area.

CPI item indexes. BLS classifies the CPI market basket of consumer goods and services into a hierarchy of categories. The top levels of the item category hierarchy consist of

• The eight major groups

• Other groups

• Expenditure classes

• Item strata

For the U.S. CPI, BLS publishes all levels down to item strata. BLS publishes less item detail for the CPI area indexes.

Special aggregations. BLS also calculates and publishes indexes for special aggregations, such as energy items, that cut across the preceding classification scheme. Some users consider the series All items less food and energy to measure the 'core' rate of inflation. Food and energy are two of the most volatile components of the CPI. For this reason, many analysts regard the measure of core inflation as more useful for their purposes.

The C-CPI-U. The Chained CPI-U uses a superlative index formula which reflects consumers' behavior in response to changes in relative prices. Unfortunately, this requires current expenditure data, and expenditure data become available only after a significant lag. Consequently, C-CPI-U index values, unlike the values of the CPI-U and CPI-W, are not final when first published. Before 2015, BLS issued two annual preliminary estimates before issuing final C-CPI-U data.9 Starting in 2015, BLS intends to issue four preliminary estimates of the C-CPI-U. The "initial" values will come out every month concurrent with the CPI-U and CPI-W. In each of the following four quarters, "interim" values will replace the initial values. One year later, the interim values will be replaced with the final C-CPI-U. For example, in February 2016, the BLS is scheduled to release the January 2016 CPIU, the CPI-W, and the initial C-CPI-U. For the next three quarters (i.e., April, July, and October of 2016), BLS will publish updated interim C-CPI-U indexes. With the fourth revision in January 2017, the January 2016 C-CPI-U will be issued as final.

Seasonally adjusted indexes and percent changes. In addition to the originally computed indexes and percent changes, which are called unadjusted indexes and unadjusted percent changes, BLS calculates and publishes seasonally adjusted series. The unadjusted numbers reflect the change in price resulting from all causes, including normal seasonal price movement due to regular changes—resulting, for example, from weather, harvests, the school year, production cycles, model changeovers, holidays, or sales—that recur every year. For economic analysis and for other purposes, it is useful to [*The first release of C-CPI-U data took place on Aug. 16, 2002. At that time, final data for the 12 months of 2000, interim data for the 12 months of 2001, and initial data for the first 7 months of 2002 were issued.*] remove the estimated seasonal effects from the original indexes and percent changes. To produce the seasonally adjusted indexes and percent changes, BLS uses seasonal adjustment techniques that remove these effects. BLS seasonally adjusts only those CPI series that pass certain statistical criteria and for which there is an economic rationale for observed seasonality. For example, while the unadjusted CPI for All items was unchanged from June 2013 to July 2013, the seasonally adjusted 1-month percent change in the CPI was 0.2 percent. Seasonally adjusted indexes are subject to annual revision and therefore are not recommended for use in escalation contracts. Seasonal adjustment is done only at the

national level for the U.S. city average CPI-U and CPI-W. Presently, the C-CPI-U does not have sufficient historical data to permit calculation of stable seasonal factors.

Average prices. For some food, beverage, and energy items, the CPI samples contain enough observations of unique items to make possible the computation and publication of meaningful average retail prices. A list of what is covered in the published average price series is shown in appendix 2.

Correction policy. The CPI, unlike many other statistical series, does not rely on respondents to transmit data to the national office. CPI data collectors collect almost all data needed for the CPI-U and CPI-W, so that routine revisions to account for late-arriving data are not necessary. Virtually all data are received in time for the calculation of indexes for the appropriate month. In rare cases, however, when we discover that we made an error collecting or compiling information, BLS issues corrections to the CPI series in accordance with BLS policy and CPI practices.

Corrections to the CPI-U and CPI-W. These series are final when issued. The CPI-U and CPI-W are commonly used in escalation agreements and to adjust pensions and tax brackets; consequently, revisions can be costly for the users of these indexes. For this reason, there is a presumption in BLS policy and practice against revisions to the CPI that extend back over lengthy periods. When a mistake is discovered, CPI staff evaluates the error in the context of BLS guidelines for issuing corrections to previously published CPI data.

Corrections to the C-CPI-U. As previously noted, C-CPIU indexes are not final when first issued. They are routinely revised, and are not final until the publication of data for the second January after initial publication. If the CPI-U and CPI-W series are corrected, the C-CPI-U series will be corrected as well. Corrected C-CPI-U indexes will be issued for all series affected by the error, as far back as the previous 5 years.

2.2.2 How to interpret the CPI

Movements of the indexes from one month to another usually are expressed as percent changes rather than changes in index points. The level of the index (relative to its base period) affects index point changes, but it does not affect percent changes. The following tabulation shows how to compute percent changes:

Index point change

CPI 222.742

Less CPI for previous period 221.317

Equals index point change 1.425

Percent change

Index point difference.....1.425

Divided by the previous index 221.317

Equals 0.006

Results multiplied by.....0.006 × 100

Equals percent change 0.6

Percent changes for periods other than 1 year often are expressed as annualized percentages. Annualized percent changes indicate what the change would be if the CPI continued to change at the same rate each month over a 12-month period. These are calculated using the standard formula for compound growth:

7 Index point difference 1.425 Divided by the previous index 222.742 Equals 0.06 Results multiplied by 100.0 0.06 × 100 Equals percent change 0.6 Percent changes for periods other than 1 year often are expressed as annualized percentages. Annualized percent changes indicate what the change would be if the CPI continued to change at the same rate each month over a 12-month period. These are calculated using the standard formula for compound growth:

$PC_{annual} = [(IX_{t+m} / IX_t)^{12/m} – 1] \times 100$,

Where

IX_t is the index in month t,

IX_{t+m} is the index m months after month t, and

PC annual is the annualized percent change.

2.2.3 Uses of the CPI

The CPI affects virtually all Americans because of the many ways in which it is used. Its major uses are as follows:

- **As an economic indicator**. As the most widely used measure of retail inflation, the CPI is a major indicator of the effectiveness of Government economic policy. The President, the Congress, and the Federal Reserve Board use the movement of the CPI to help formulate and monitor the effect of fiscal and monetary policies. Business executives, labor leaders, and other private citizens also use the index as a guide in making economic decisions.

- **As a means of adjusting income payments**. The index directly affects the income of almost 80 million people. Social Security benefits and military and Federal Civil Service pension payments are all indexed by the CPI. In the private sector, many collective bargaining agreements tie automatic wage increases to the CPI. Some private firms and individuals use the index to keep rents, alimony, and child support payments in line with changing prices.

• **As a means of preventing inflation-induced tax changes**. Federal (and some state) income tax brackets and other parameters are adjusted by the CPI. This prevents inflation from automatically increasing taxes, a phenomenon called bracket creep.

• **As a deflator of other economic series**. Other statistical programs use the CPI or its components to adjust for price changes and produce inflation-free versions of their series. Examples of CPI-adjusted series include components of the U.S. Department of Commerce National Income and Product Accounts (such as gross domestic product and personal consumption expenditures) and retail sales measures and the BLS hourly and weekly earnings series.

2.2.4 Limitations of the index

The CPI covers a wide variety of items that all urban consumers purchase, but—because most individuals concentrate spending on a relatively small fraction of the total number of items available in the market—it contains items that a given individual does not purchase. The CPI must represent a composite consumer, and it does not necessarily represent the price-change experience of any one individual, household, or family. Similarly, the CPI may not be applicable to all questions about price movements for all population groups.

As previously noted, CPI indexes cannot be used to determine relative living costs. The CPIs for various geographic areas of the United States do not indicate the differences in price level among them. The change in the CPI for an individual area measures the degree to which prices have changed over time within that particular area. It does not show whether prices or living costs are higher or lower in that area relative to another area or to the United States as a whole. Comparing indexes between one area and another indicates which area has experienced more rapid price change—not which area has a higher price level or higher living costs.

Sampling and non-sampling error. The CPI is estimated from a sample of consumer purchases; it is not a complete measure of price change. Consequently, the index results may deviate slightly from those that would be obtained if all consumer transactions were covered. This is called sampling error. These estimating or sampling errors are statistical limitations of the index.

A different kind of error in the CPI can occur when, for example, a respondent provides BLS economic assistants with inaccurate or incomplete information. This is called non sampling error. BLS attempts to minimize these errors by obtaining prices through personal observation whenever possible, and by correcting errors immediately upon discovery. The economic assistants, technicians, and commodity specialists who collect, process, and analyze the data are trained to watch for deviations in reported prices that might be due to errors.

A full discussion of the varieties and sources of possible error in the index is presented in part III of this chapter, “Precision of CPI Estimates.”

Experimental indexes: Population subgroups. The CPI also calculates and publishes some indexes on an experimental basis only. For example, the program provides experimental indexes for the elderly.

Comparing indexes for such subgroups does not indicate whether the prices they pay are higher or lower than the prices other groups pay; this comparison indicates only whether prices of their items have risen faster or slower than those for other groups. Indexes for subgroups of the population are more difficult to construct than indexes for the whole. In particular, making sure that samples refer to only part of the population may be difficult or impractical. Moreover, making subgroup indexes as precise as the national CPI would require that the sample sizes be as large.

The experimental CPI for Americans 62 Years of age and older (CPI-E). BLS occasionally issues a report on its experimental index for the elderly. This index, sometimes referred to as the CPI for the elderly or CPI-E, is calculated monthly and is available on request. It should be emphasized that the CPI-E is merely a reweighting of the CPI basic indexes using expenditure weights from households headed by someone 62 years of age or older. There is no attempt to recalculate the basic indexes themselves so that they represent the retail outlets and consumption items of older consumers.

CPI research series. Over the years, BLS has made many improvements to the CPI. When BLS changes its methods, it always announces them in advance and, if possible, estimates the impact the change would have had in recent periods. BLS does not, however, revise previously published CPI data to reflect the new methods. This practice means that the movement of the CPI reflects not only price change over time but also changes to CPI methods. To assist users who wish to use the CPI over long periods, BLS publishes the CPI-U Research Series Using Current Methods (CPI-U-RS). It provides estimates, for the period since 1977, of what the CPI would have been had the most current methods been in effect. Each time there are new methods introduced into the CPI, the CPI-U-RS is revised from 1978 forward.

History of the U.S. CPI, 1919 to 2002. The CPI was initiated during World War I, when rapid increases in prices, particularly in shipbuilding centers, made such an index essential for calculating cost-of-living adjustments in wages. To provide appropriate weighting patterns for the index, so that it would reflect the relative importance of goods and services purchased by consumers, studies of family expenditures were conducted in 92 industrial centers in 1917–1919. Periodic collection of prices was started and, in 1919, BLS began publication of separate indexes for 32 cities. Regular publication of a national index, the U.S. city average, began in 1921, and indexes were estimated back to 1913.

Since its inception, the CPI has been comprehensively revised on several occasions to implement updated samples and weights, expanded coverage, and enhanced methodologies. For example, the 1998 revision introduced more timely consumer spending weights; updated geographic and housing samples; a revised item classification structure; a new housing index estimation system; computer-assisted price collection; and a new Telephone Point-of-Purchase Survey (TPOPS). BLS also has made important improvements to the CPI beyond the major revision processes, an example being the introduction of the geometric mean formula in January 1999. Exhibit 1 provides a chronology of revisions and improvements to the CPI, displays historical changes in base period, population coverage, and other index characteristics.

The improvements introduced over the years have reflected not only the Bureau's own experience and research, but also the criticisms and investigations of outsiders. For example, in undertaking the 1940

comprehensive revision of the CPI, BLS acted on recommendations made by an Advisory Committee appointed by the American Statistical Association. Major studies were conducted during World War II by the President's Committee on the Cost of Living and in 1951 by the House Committee on Education and Labor.

The 1961 report of the Price Statistics Review Committee (sometimes called the "Stigler Committee") provided impetus for subsequent changes in many aspects of the CPI, including the sampling of outlets and items, the treatment of quality changes in consumer durables, and the role of cost-of-living theory. Recent studies include the 1996 report of the Advisory Commission to Study the Consumer Price Index (the "Boskin Commission") and the 2002 report, At what price? Conceptualizing and measuring cost-of-living and price indexes, by a National Research Council panel of the National Academy of Sciences. A continuing flow of articles in professional journals and books also has contributed to the assessment of the CPI's quality and of the ways in which it might be improved.

2.2.5 Exhibit 1. Chronology of changes in the Consumer Price Index

The Consumer Price Index to 1940

• Began publication of separate indexes for 32 cities (1919): Collected prices in central cities periodically
• "Developed weights from a study that BLS conducted in 1917–1919 of family expenditures in 92 industrial centers, reflecting the relative importance of goods and services purchased by consumers" Reflected the relative importance of goods and services purchased by consumers

• Collected prices for major groups: Food, clothing, rent, fuels, house furnishings, and miscellaneous

• Limited pricing to items selected in advance to represent their categories

• Began regular publication of a national index, the U.S. city average (1921):

Based index on an unweighted average of the city indexes

Estimated U.S. city average back to 1913, using food prices only

The 1940 CPI revision: the first comprehensive revision

• Used weights based on 1934–1936 study of consumer expenditures

• Collected prices in the 34 largest cities

Implemented a weighted average of cities for the U.S. city average CPI

Improvements made between the 1940 and 1953 revisions

• During World War II:

Discontinued the pricing of unavailable items, such as new cars and household appliances

Increased the weight of other items, including automobile repair and public transportation in 1951: Adjusted weights in seven cities, using a 1947 and 1949 survey of consumer expenditures

Adjusted weights for the 1950 Census

Adjusted rent index to remove “new unit bias” caused by rent control

Added new items to the list of covered items, including frozen foods and televisions

The 1953 CPI revision: the second comprehensive revision

• Used weights from a 1950 expenditure survey conducted in central cities and attached urbanized areas

• Refined the target population to include urban wage earner and clerical worker families

• Added a sample of medium and small cities

• Updated the list of items that the index covered, adding restaurant meals

• Added new sources of price data

• Improved pricing and calculation methods

The 1964 CPI revision: the third comprehensive revision

• Based weights on 1960–1961 expenditure patterns in metropolitan areas

• Added single-person households to target population: urban wage earner and clerical worker households

• Extended pricing to the suburbs of sampled metropolitan areas

• Updated the sample of cities, goods and services, and retail stores and service establishments

Improvements made between the 1964 and 1978 revisions

• Made quality adjustments for new vehicles at model changeover

• Improved treatment of seasonal items

The 1978 CPI revision: the fourth comprehensive revision

• Added a new Consumer Price Index: the CPI for All Urban Consumers, or the CPI-U 9

• Renamed the older CPI [as] the CPI for Urban Wage Earners and Clerical Workers, or the CPI-W • Used weights from a 1972–1973 survey of consumer expenditures and the 1970 census

• Expanded the sample to 85 areas

• Increased minimum pricing frequency from quarterly to bimonthly

• Implemented monthly pricing in five largest areas

• Introduced probability sampling methods at all stages of CPI sampling

• Introduced checklists that define each category of spending

• Developed estimates of the CPI's sampling error and optimal sample allocation to minimize that error

Improvements made between the 1978 and 1987 revisions

• Began systematic replacement of outlets and their item samples between major revisions (1981): Implemented new Point-of-Purchase Survey (POPS)

Selected retail outlets with probability proportional to consumer spending therein

Eliminated reliance on outdated secondary-source sampling frames

Began rotating outlet and item samples every 5 years

Began rotating one-fifth of the CPI pricing areas each year

• Introduced rental equivalence concept (January 1983 for the CPI-U; January 1985 for the CPI-W)

The 1987 CPI revision: the fifth comprehensive revision

• Used weights from the 1982–1984 Consumer Expenditure Survey and the 1980 Census

• Updated samples of items, outlets, and areas

• Redesigned the CPI housing survey

• Improved sampling, data collection, data-processing, and statistical estimation methods

• Initiated more efficient sample design and sample allocation

• Introduced techniques to make CPI production and calculation more efficient

Improvements made between the 1987 and 1998 revisions

• Improved housing estimator to account for the aging of the sample housing units

• Improved the handling of new models of vehicles and other goods

• Implemented new sample procedures to prevent overweighting items whose prices are likely to rise

• Improved seasonal adjustment methods

• Initiated a single hospital services item stratum with a treatment-oriented item definition

• Discontinued pricing of the inputs to hospital services

The 1998 CPI revision: the sixth comprehensive revision

• Weights from the 1993–1995 Consumer Expenditure Survey and the 1990 census

• Updated geographic and housing samples

• Extensively revised item classification system

• Implemented new housing index estimation system

• Used computer-assisted data collection

• Added the Telephone Point-of-Purchase Survey (TPOPS):

Allows rotation of outlet and item samples by item category and geographic area, rather than by area alone

Improvements since the 1998 Revision

• Initiated a new housing survey based on the 1990 census (January 1999):

Estimated price change for owners' equivalent rent directly from rents

Began using a geometric mean formula for most basic indexes (January 1999):

Mitigates lower level substitution bias

• Reflects shifts in consumer spending with item categories as relative price change

• Extended the use of hedonic regression to estimate the value of items changing in quality

• Directed replacement of sample items in the personal computer and other categories, to keep samples current

• Implemented 4-year outlet rotation to replace 5-year scheme

• Began within-outlet item rotation for prescription drugs and other item categories

• Implemented biennial weight updates starting January 2002

• Increased sample size of the Consumer Expenditure Survey, so that CPI weights could be based on just 2 years of data

Added the Chained Consumer Price Index for All Urban Consumers (C-CPI-U) (August 2002)

• Uses more advanced "superlative" index formula (the Törnqvist formula)

• Corrects upper-level substitution bias

• Expanded collection of price data to all business days of the month (Before 2004, prices were collected the first 18 business days of the month for the first 10 months of the year and the first 15 business days for November and December.)

• Began publishing indexes to three decimal places (January 2007)

2.2.6 Part II. Construction of the U.S CPI

Sampling: areas, items, and outlets

The smallest geographic areas in which pricing is done for the CPI are called primary sampling units (PSUs). Within these areas, sales outlets are chosen where people shop and live. The selected non shelter outlets are matched to a sample of items that these consumers buy. Appendix 4 lists the 87 PSUs selected for the 1998 revision and the counties contained therein. Prices from these were introduced into CPI index calculation with the release of the January 1998 index.

Area sample. For the purpose of selecting the 1998 CPI PSU sample, the entire United States was divided into PSUs. First, BLS used the U.S. Office of Management and Budget (OMB) definition of Metropolitan Areas (MAs) to divide the country into metropolitan and nonmetropolitan areas. The PSUs within the metropolitan area are, with five exceptions, always OMB-defined MAs. In the nonmetropolitan areas, BLS defined the PSU boundaries. In general, a PSU is delineated by county borders (with some exceptions in New England) and can comprise several counties.

Each PSU was first classified by its size. All PSUs with populations larger than 1.5 million were declared to be self-representing and given the size type of A. The remaining non-self-representing PSUs, metropolitan and nonmetropolitan, are called B and C PSUs, respectively. (To avoid confusion, it is important to recognize the distinction between the naming conventions for PSUs and those for CPI size-class indexes. In general, prices collected in B PSUs are used to compute the B/C CPI indexes, and prices in C PSUs are used in the computation of the D CPI indexes. The exceptions are the Anchorage and Honolulu metropolitan areas, which are A PSUs but included in the B/C size class indexes.)

The second classification variable for PSUs is census region. The next phase of the area selection was to stratify (group) PSUs in each region-size class; for example, South B into strata (groups) of similar PSUs based on their scores on several factors (called stratifying variables). Each A PSU is in a stratum by itself, thus, the name “self-representing.” Selection of the stratifying variables was based on linear regression modeling of price change (sequentially finding sums of a constant and a constant times each of a subset of 1990 census and geographic PSU variables that best explain CPI price change over different periods). The variables (called geographic variables) used in all stratifications except that for the South B PSUs were percent urban, the normalized latitude and longitude of the PSU’s geographic center, and normalized longitude squared. In the stratification of the South B PSUs, percent urban and variables used in the 1987 Revision—namely, mean interest and dividend income per consumer unit (CU), mean CU wage and salary income, percent housing units (HUs) heated by electricity, percent HUs heated by fuel oil, percent owner-occupied HUs; percent black CUs, and percent CUs with retired person—were used. The program employed to do the stratifications was a modified version of the Friedman-Rubin

clustering algorithm, which puts PSUs in the same stratum based on their similarities on the stratification variables, while keeping the population sizes of the strata approximately equal.

A program was used to select one PSU per stratum so that the selected PSUs were well-distributed over the States and there were many 1988-sample PSUs among the newly selected ones.24 Prices from the 36 newly-selected non-1988-sample PSUs were introduced into CPI index calculations in 1998. Since 1998, indexes have been published monthly for the New York, Los Angeles and Chicago Consolidated Metropolitan Statistical Areas (CMSAs). Indexes for the Washington-Baltimore CMSA, along with the next 10 largest A *[In case the CPI-T was judged too costly, a selection was made from nonmetropolitan PSUs that would have their urban parts included in the CPI-U. Candidate PSUs had to contain some urban population. From these candidates, a probability (proportional to the urban population of their stratum) sample for the CPI-U was selected in each region except the Northeast. Long after the selection of the PSUs, a decision was made not to publish a CPI-T because of its increased cost. At that time, 18 of the previously selected PSUs were dropped from the CPI sample and its increased cost. At that time, 18 of the previously selected PSUs were dropped from the CPI sample and designated as "Consumer Expenditure Survey only" PSUs.]* PSUs (not including those contained in the aforementioned CMSAs), are published bimonthly. Beginning in January and July, semiannual indexes are published for the 12 smallest A PSUs. Indexes are also published for the U.S. total as well as for region and size class totals, with the exception of the D indexes in the Northeast and West. Beginning in 2002, semiannual indexes have been published for Phoenix.

Replicates, which are used in variance calculation, are assigned to each A PSU based on population, with each A PSU having either two or four replicates. B and C PSUs are paired in each region, with each pair containing a PSU on the even and odd monthly pricing cycles, except for single PSU pairs in the region-size classes in which the number of PSUs is not a multiple of 4. Publication of a region-size class requires at least four PSUs (two replicates). The actual allocation of replicates is provided in the next section, along with the allocation of replicate panels.

Item and outlet samples

Commodities and services other than shelter: Item structure and sampling. The CPI item structure has four levels of classification. The eight major groups are made up of 70 expenditure classes (ECs), which in turn are divided into 211 item strata. Major groups and ECs do not figure directly in CPI sample selection, although ECs are used in smoothing item stratum expenditure estimates during composite estimation. Within each item stratum, one or more substrata, called entry-level items (ELIs), are defined. ELIs are the ultimate sampling units for items as selected by the BLS national office. They represent the level of item definition from which data collectors begin item sampling within each sample outlet.

To enable the CPI to reflect changes in the marketplace, new item and outlet samples are selected each year, on a rotating basis, for approximately 25 percent of the item strata in each PSU. Each year, four regional item universes are tabulated from the two most recent years of CE data. Independent samples of ELIs are selected from the corresponding regional item universe for each item stratum PSU-replicate scheduled for rotation that year. Within each sample PSU-replicate, each item sample is based on a

systematic probability-proportional-to-size (PPS) sampling procedure, in which each ELI has a probability of selection proportional to the CPI-U population expenditures for the region for the ELI within its stratum.

Item and outlet sample design. The CPI uses two separate sample designs, one for rent and owners' equivalent rent, and one for all other commodities and services. The methodology used to determine the commodities and services item and outlet sample design is presented here in brief. The design for the rent and owners' equivalent rent indexes is described later. *[For the A PSUs, the number of replicate panels (or groups) is the same as the number of replicates. Each non-self-representing PSU is allocated one replicate panel.]*

The primary objective of the Commodities and Services (C&S) sample design is to determine an allocation of individual item and outlet selections, by item stratum and by PSU, replicate, and POPS category (see list that follows), that minimizes the sampling variance of price change measured by the all-cities C&S CPI, subject to certain budgetary and sample size constraints. Models are used to project the sampling variance and data collection costs in terms of the decision variables for the sample design. For these models, all commodities and services item strata are grouped into 13 major groups:

- Food at home—non meat staples
- Food at home—meat, poultry, fish
- Food at home—fruits and vegetables
- Other food at home, plus beverages (alcoholic and nonalcoholic)
- Food away from home
- Fuels and utilities
- Household furnishings and operations
- Apparel
- Transportation less motor fuel
- Motor fuel
- Medical care
- Education and communication
- Recreation and other commodities and services

In brief, the C&S sample allocation methodology is as follows: First, a variance function that projects the variance of price change as a function of the preceding variables for the commodity and service components is modeled. Second, a cost function that predicts the total annual cost of the commodity

and service components of the CPI is modeled. Third, values for all coefficients of the two functions, including estimates of outlet sample overlap, are estimated. Fourth, nonlinear programming techniques are used to determine approximately optimal sizes for the item and outlet samples needed to minimize the CPI variance under varying assumptions of annual price change subject to cost constraints. The variance and cost functions for the CPI are modeled for 15 PSU groups:

PSU group name

• New York City

• New York City suburbs

• Los Angeles City

• Los Angeles suburbs

• Chicago

• Philadelphia and San Francisco

• Detroit and Boston

• Other large self-representing PSUs

• Small self-representing PSUs

• Medium-sized PSUs, Census Region 1

• Medium-sized PSUs, Census Region 2

• Medium-sized PSUs, Census Region 3 • Medium-sized PSUs, Census Region 4 • Small PSUs, Census Regions 1–4

• Anchorage and Honolulu

A detailed discussion of the sample allocation methodology is provided in appendix 6. The allocation is resolved with each C&S sample rotation, which occurs twice each year, and allocations change as sample frames are refreshed and rotated. For ongoing pricing, about 27,000 outlets are visited each month, with prices collected for about 83,400 commodities and services.

Outlet and price surveys. BLS economic assistants collect prices monthly for food at home, energy, and selected other commodity and service item strata in all PSUs. Items that are priced monthly typically are those with more volatile and variable price movement. Commodities and services priced monthly in all PSUs is given in exhibit 2. Prices also are collected monthly for all commodity and service item strata in the three largest publication areas: New York, Los Angeles, and Chicago. Prices are collected bimonthly in the remaining PSUs for the C&S item strata not cited in the list. Those are assigned to either even- or odd-numbered months for pricing.

2.2.7 Exhibit 2. Consumer Price Index (CPI) items priced monthly everywhere

All food at home items

Housing at school, excluding board

Other lodging away from home, including hotels and motels

Tenants' and household insurance

Fuel oil

Propane, kerosene, and firewood

Electricity

Utility (piped) gas service

Used cars and trucks

Gasoline (all types)

Other motor fuels

Tires

Vehicle accessories other than tires

State and local registration, license, and motor vehicle

property tax

Parking and tolls

Newspapers and magazines

Recreational books

Postage

Delivery services

Land line telephone services

Wireless telephone services

Cigarettes

Tobacco products other than cigarettes

Telephone Point-of-Purchase Survey (TPOPS). The U.S. Census Bureau conducts the TPOPS for BLS. The survey furnishes data on retail outlets from which metropolitan and urban nonmetropolitan households purchased defined groups of commodities and services to be priced in the CPI. Commodities and services are grouped into sampling categories, called POPS categories. These categories are based on ELIs as defined in the CPI classification structure. Some POPS categories consist of only one ELI, while others consist of multiple ELIs. ELIs are combined into a single POPS category when the commodities or services generally are sold in the same outlets. TPOPS uses random-digit dialing to select households for participation in the survey. Within each PSU, banks of landline telephone and cell phone numbers containing at least some residential phone numbers are identified. Among these identified banks, numbers are then randomly dialed. Inevitably, some of the dialed numbers such as nonworking, ring-no-answer, business, and FAX machine telephone numbers are ineligible for TPOPS interviewing. Some numbers belong to ineligible households, such as military households.

Eligible respondents include all civilian, non-institutional persons residing in regular residences, boarding houses, student or worker housing, mobile home parks, and permanent-type living quarters in hotels and motels, as well as staff residing in institutions. Not all of the eligible telephone numbers are productive, however, as respondent refusals are unavoidable. BLS specifies a target number of completed TPOPS interviews for each PSU. In the small and medium-sized PSUs, that target number is 110 completed interviews. For most of the self-representing PSUs, the target number of completed interviews ranges from 200 to 400. In New York City and Chicago, the target number of completed interviews is 460. In Los Angeles, the specified goal is 500. Upon first contact and after determining the eligibility and willingness of the household, a Census Bureau interviewer asks a variety of administrative and demographic questions. This information allows BLS to monitor how well the selected households represent the overall population, as well as to analyze the shopping patterns of various segments of the population.

Any given responsive household is called once a quarter for four successive quarters. Each time, the interviewer administers the survey to the original respondent, if possible. During each interview, the respondent is asked whether the household had expenditures for a set of POPS categories over a duration of time called a “recall period.” Recall periods are POPS-category-specific and vary from 1 week to 5 years. The recall period for a specific POPS category is defined to produce a sufficient, but not excessive, number of outlets for sampling purposes. For instance, because households tend to purchase gasoline frequently, a 1-week recall period is used. In contrast, people tend to purchase cars and funeral services infrequently; therefore a 5-year recall period is assigned. If the respondent reports expenditures for a particular POPS category, the interviewer prompts the respondent for the outlet name, location, and amount spent. At the end of each quarter of interviewing, the Census Bureau sends the TPOPS outlet frame data to BLS for processing. BLS processes TPOPS data two quarters at a time. The primary objective of BLS processing of TPOPS data is to select a sample of outlets at which specific items ultimately will be priced for inclusion in the CPI. The expenditure amounts reported in TPOPS are used as outlet selection probabilities.

TPOPS employs a quarterly rotating-panel sample design. On a quarterly basis, every PSU is assigned 1 of 16 TPOPS questionnaires. Each questionnaire consists of up to 16 POPS categories. In a particular

quarter and for a particular PSU, the selected TPOPS respondents are asked about expenditures made for some or all of the POPS categories on the assigned questionnaire. During each subsequent quarter of TPOPS interviewing, the given PSU is administered a different questionnaire until each of the 16 questionnaires has been administered. It takes 4 years of quarterly interviewing to rotate through all 16 questionnaires. After the 4 years, the cycle for the PSU starts over again. In this manner, all TPOPS samples are refreshed once every 4 years. This practice is repeated for each PSU. The quarterly pattern of assigned POPS categories varies from PSU to PSU in a strategic fashion to ensure that every POPS group is assigned to at least a few PSUs every quarter.

Outlet sampling procedures. The design for TPOPS provides for the rotation of approximately one-quarter of the items in each sample PSU during the course of each year. With each rotation, item samples and outlet samples are selected for the designated items and corresponding POPS categories. In self-representing PSUs, sample households for each TPOPS rotation are divided into two or more independent groups. This process defines two or more frames of outlets per category-PSU for outlet selection. The principal purpose of constructing these independent groups, or replicate panels, is for variance estimation. A single subset of independently selected ELIs and outlets for all item strata within a PSU is called a replicate. The number of replicates per PSU group and the number of PSUs in each PSU group are given in table 1.

Reported expenditures for each outlet within the frame for each POPS category and PSU-replicate are edited prior to sample selection. Sometimes, a purchase is reported for an outlet but the amount of expenditures is not reported; to ensure a chance of selection for the outlet in those cases, the mean expenditure for outlets for the POPS category-PSU-replicate is assigned to the outlet. Large expenditure totals for an outlet are edited, in some cases, to be no greater than 25 percent of the total expenditure reported for the POPS category-PSU-replicate. In cases in which there are more than 20 outlets reported for a POPS category-PSU-replicate, the largest reported expenditures are trimmed to be no greater than 10 percent of the total reported for that POPS category-PSU-replicate.

Table 1. Construction of replicate panels

No.	PSU Group	Number of PSUs	Number of replicate panels
1	New York City	1	4
2	New York City Suburbs	2	4
3	Los Angeles City	1	4
4	Los Angeles City Suburbs	1	2
5	Chicago	1	4
6	Philadelphia and San Francisco	2	4
7	Detroit and Boston	2	4
8	Other Large Self representing PSUs	7	14
9	Small representing PSUs	12	24
10	Medium-sized PSUs, Census region 1	8	8
11	Medium-sized PSUs, Census region 2	10	10
12	Medium Sized PSUs, Census region 3	22	22
13	Medium Sized PSUs, Census region 4	6	6
14	Small PSUs, Census Region 1-4	10	10
15	Anchorage and Honolulu	2	4

Source: U.S. Bureau of Labor Statistics.

Outlet samples are selected independently for each PSU, replicate, and POPS category using a systematic PPS sampling procedure. Each outlet in a frame has a probability of selection proportional to the total expenditures reported for the outlet in the POPS category in the TPOPS survey. In each PSU-replicate, all ELIs selected in the item sampling process are assigned for pricing to each sample outlet selected from the frame for the corresponding POPS categories. When multiple selections of a sample outlet occur, a commensurate increase is made in the number of quotes priced for the outlet.

Outlet sampling procedures for commodities and services not included in the TPOPS. Some commodity and service items are excluded from the TPOPS, either because existing sampling frames are adequate or because it became apparent that the TPOPS would not yield an adequate sampling frame. For each of these items (non-POPS), BLS either constructs the sampling frame or acquires it from another source. Each non-POPS item has its own sample design. The frames consist of all outlets providing the commodity or service in each sample area. A measure of size is associated with each outlet on the sampling frame. Ideally, this measure is the amount of revenue generated by the outlet from the item for the CPI-U population in the sample area. Whenever revenue is not available, an alternative measure

of size, such as employment, number of customers, or sales volume, is substituted. All samples are selected using systematic sampling techniques with probability proportional to the measure of size.

Merging item and outlet samples. Item and outlet samples, which are selected independently, must be merged before data collection. A concordance that maps ELIs to POPS categories allows each sampled ELI to be assigned for price collection to the outlet sample selected for the POPS category that contains it. The number of price quotes for an ELI in each outlet thus equals the number of times the ELI was selected for pricing in the PSU- replicate during the item sampling process. The item-outlet sample merge determines the number of price quotes assigned for collection in each sample outlet. In the outlet sampling process, outlets with large expenditure reports may be selected more than once from the frame for a given POPS category. An outlet also may be selected from the frame for more than one POPS category. If an outlet is selected multiple times for a given POPS category, the same multiple of price quotes is assigned for collection for each sample ELI matching the category. If an outlet is selected for more than one POPS category, price quotes are assigned for collection for all ELIs selected in each category.

Selection procedures within outlets. A BLS economic assistant visits each selected outlet. For each ELI assigned to the outlet for price collection, the economic assistant uses a multistage probability selection technique to select a specific item from among all the items the outlet sells that fall within the ELI definition. The economic assistant first identifies all of the items included in the ELI definition and offered for sale by the outlet. When there are a large number of items in the ELI, the assistant groups them by common characteristics, such as brand, size, or type of packaging. With the assistance of the respondent for the outlet, the economic assistant assigns probabilities of selection to each group.

The probabilities of selection are proportional to the sales of the items included in each group. The economic assistant may use any of the following four procedures, listed in order of preference, for determining the proportion of sales:

- Obtaining the proportions directly from a respondent
- Ranking the groups by importance of sales as indicated by the respondent, and then obtaining the proportions directly or using assigned proportions
- Using shelf space to estimate the proportions, where applicable
- Using equal probability

After assigning probabilities of selection, the economic assistant uses a random-number table to select one group. The economic assistant then identifies all items included in the selected group, forms groups of those items based on the in common characteristics, assigns probabilities to each group, and uses a random number table to select one. The economic assistant repeats this process through successive stages until reaching a unique item. The economic assistant describes the selected unique item on a checklist for the ELI. Checklists contain the descriptive characteristics necessary to identify the item among all items defined within the ELI.

These selection procedures ensure that there is an objective and efficient probability sampling of CPI items other than shelter. They also allow broad definitions of ELIs, so that the same unique item need not be priced everywhere. The wide variety of specific items greatly reduces the within item component of variance, reduces the correlation of price movement between areas, and allows a substantial reduction in the number of quotes required to achieve a given variance. Another important benefit from the broader ELIs is a significantly higher likelihood of finding a price able item within the definition of the ELI in the sample outlet.

This selection process is completed during the visit to the outlet to obtain the price for the selected item. Subsequently, personal visits or telephone calls are made, either monthly or bimonthly, to ascertain that the item is still sold and to obtain its current price.

Computer-assisted data collection for commodities and services. A computer-assisted data collection (CADC) system has been used in the C&S survey since September 2002. The data collection instrument is composed of two main modules. The interactive electronic checklists of item specifications allow the data collector to identify the same item upon returning to an outlet, to substitute a similar item, or to initiate a new item for pricing. Each ELI is subdivided into clusters, with each cluster having its own set of specifications. Checklists contain descriptive information about items, including features of the items themselves and components of the item that might affect the price. A checklist can be a straightforward list of specifications, or it can be fairly complex, with hierarchical dependencies among specifications and complicated mathematical formulas. The interactive electronic checklist enforces rules regarding patterns of specifications that may be necessary to identify an item. The checklist also prevents inconsistencies.

The other module of the C&S CADC collection instrument comprises some screens that make up the pricing form and various functions pertaining to the task of data collection. For instance, some screens enable the economic assistant to organize his or her work at the level of the outlet or the quote, while some allow review of collected data or information about the outlet and respondent. An economic assistant selects an action, such as substituting a new item for one that is unavailable (only options that are appropriate for that action are offered in the collection instrument). The pricing screens allow the economic assistant to enter the price of the item as well as relevant information about it, such as quantity, size, unit of size, sales tax, and seasonality; the economic assistant can also see the previous price and other data relevant to the quote.

Electronic data collection improves data quality in part by activating important rules at the moment the data are being collected. For instance, a suspiciously large price change can 16 be noted immediately, rather than after data have been sent to Washington, DC and examined by commodity analysts. The collection instrument contains multiple edits which either warn the economic assistants about some important aspect of a quote or prevent them from entering invalid information. CPI data collection is scheduled in terms of business days (that is, weekdays excluding holidays). Before 2004, data collection covered three pricing periods, each comprising 6 business days in most months and 5 days in November and December. Consequently, the last scheduled data collection was usually the 18th business day of

the month. Beginning with data for January 2004, the three pricing periods now are of variable length and end on the last business day of the month.

Shelter

The CPI housing unit sample is the source of the data on residential rents used to calculate changes in rents for the rent of primary residence (rent) index. The housing survey also uses these rent data in calculating changes in the rental value of owned homes for the owners' equivalent rent of primary residence (OER) index. These two shelter indexes account for approximately 30 percent of the total CPI weight.

Weighting during segment sample selection. In the 1999 Housing Sample, segments were selected with probability proportional to size, the size measure being estimated expenditures. In the segment selection process, the segments are ordered within each PSU by county and then by segment rent level within county. Because the segment selection is systematic, this guarantees that not all high-rent or low-rent segments are chosen and that the segments will be geographically distributed within the PSU. Each segment, s, was assigned a probability of selection, P, within the PSU, which is the ratio of the cost of housing in the segment relative to the cost of housing in the PSU times the number of segments selected. Therefore,

$$P_s = [TC_S / \sum_{s \in PSU} TC_S] \times n_{PSU},$$

where

n_{PSU} = number of segments chosen in the PSU,

and

TC_S is as defined in the next paragraph.

Each segment also has a weight Ws , which is the reciprocal of the probability of selection. Therefore,

$$Ws = 1/Ps .$$

The total cost of housing in the segment, TC is the cost of rented housing in the segment, RCs , plus the cost of owned housing in the segment, OCs . RCs is the number of rented housing units in the segment Rs times the average rent value within the segment (RRs). (OCs) is the number of owned housing units in the segment times an estimated average owner equivalent rent value within the segment, IRs . This gives segments with higher valued units (higher rent levels) a higher probability of selection and a lower segment weight:

$$TCs = RCs + OCs = Rs \times RRs + Os \times IRs .$$

The number of owned housing units, the number of rented housing units, and the average rent value were taken from the decennial census. The estimated average owner equivalent rent value was determined by a linear regression on Consumer Expenditure Survey property value, income, and

number of rooms. The resulting regression coefficients were applied to decennial census values for the same independent variables to estimate the average owner's equivalent rent for each segment.

The following is the nonlinear regression that was used:

oerval = bo + (b1 × propval) + (b2 × propval2) + (b3 × income) + (b4 × rooms).

In this equation,

oerval = the value the home would rent for,

propval = the market value of the home,

income = the income of the consumer unit, and

rooms = the number of rooms in the house.

The actual regression coefficients were determined uniquely for each index area.

Because rents are not volatile, the housing sample is divided into panels; one panel is priced each month and each panel is priced twice a year. For example, panel 1 is priced in January and July, panel 2 in February and August, and so on through panel 6. The segments within the strata are assigned to these panels. These assignments are made such that each panel has a representative subsample of the PSU. Because each panel is representative of the entire sample, there is never an off-cycle month for the housing survey, a panel of data provides sufficient information for monthly publication of the rent and rental equivalence (REQ) indexes. Segments were selected within the PSUs in multiples of 6, so that each panel had the same sample size within a PSU.

About 10,000 segments were selected in the PSUs. The housing sample is designed to consist of approximately 50,000 rental units. Sampling rates were computed for each segment so that the sample design would be realized after the sampling and screening processes described next were completed.

Sample allocation to PSUs. BLS allocated the sample to PSUs based on the estimated total housing expenditure in each PSU. The estimated total housing PSU expenditure is the sum of the total cost of housing, previously defined, across all segments:

$$\text{PSU expenditure} = \sum_{s \in S} TC_s.$$

There are six collection panels. It was desired that the segment sample size be equal within each collection panel. Thus, the segment were allocated in blocks of 6 segments, with a minimum of 72 segments per PSU. For Psu_s with multiple replicates, it was desired to have at least 36 segments per replicate and an equal sample size in each replicate. It was determined that a minimum of 108 segments was needed to support publication in areas that were published semi-annually and that a minimum of 180 segments was needed for areas that are published bimonthly. The one exception was Baltimore, which received 108 segments but is published bi-monthly as part of the Washington-Baltimore CMSA. As

the sample size was previously about 10,000 segments and the budget for housing data collection was comparable, multiples of 6 segments were chosen so that the total would be near10,000 segments.

Specifications. Checklists contain descriptive information about items, including features of the items themselves and components of the item that might affect the price. A checklist can be a straightforward list of specifications, or it can be fairly complex, with hierarchical dependencies among specifications and complicated mathematical formulas. The interactive electronic checklist enforces rules regarding patterns of specifications that may be necessary to identify an item. The checklist also prevents inconsistencies. The other module of the C&S CADC collection instrument comprises some screens that make up the pricing form and various functions pertaining to the task of data collection. For instance, some screens enable the economic assistant to organize his or her work at the level of the outlet or the quote, while some allow review of collected data or information about the outlet and respondent.

An economic assistant selects an action, such as substituting a new item for one that is unavailable (only options that are appropriate for that action are offered in the collection instrument). The pricing screens allow the economic assistant to enter the price of the item as well as relevant information about it, such as quantity, size, unit of size, sales tax, and seasonality; the economic assistant can also see the previous price and other data relevant to the quote. Electronic data collection improves data quality in part by activating important rules at the moment the data are being collected. For instance, a suspiciously large price change can be noted immediately, rather than after data have been sent to Washington, DC and examined by commodity analysts. The collection instrument contains multiple edits which either warn the economic assistants about some important aspect of a quote or prevent them from entering invalid information. CPI data collection is scheduled in terms of business days (that is, weekdays excluding holidays). Before 2004, data collection covered three pricing periods, each comprising 6 business days in most months and 5 days in November and December. Consequently, the last scheduled data collection was usually the 18th business day of the month. Beginning with data for January 2004, the three pricing periods now are of variable length and end on the last business day of the month. Shelter The CPI housing unit sample is the source of the data on residential rents used to calculate changes in rents for the rent of primary residence (rent) index. The housing survey also uses these rent data in calculating changes in the rental value of owned homes for the owners' equivalent rent of primary residence (OER) index. These two shelter indexes account for approximately 30 percent of the total CPI weight.

Weighting during segment sample selection. In the 1999 Housing Sample, segments were selected with probability proportional to size, the size measure being estimated expenditures. In the segment selection process, the segments are ordered within each PSU by county and then by segment rent level within county. Because the segment selection is systematic, this guarantees that not all high-rent or low-rent segments are chosen and that the segments will be geographically distributed within the PSU. Each segment, s, was assigned a probability of selection, P, within the PSU, which is the ratio of the cost of housing in the segment TCs relative to the cost of housing in the PSU times the number of segments selected. Therefore, PSU s∈PSU TCs Ps TCs / $(1 \times n) = \sum$, where There are six collection panels. It was desired that the segment sample size be equal within each collection panel. Thus, the segments were allocated in blocks of 6 segments, with a minimum of 72 segments per PSU. For PSUs with multiple replicates, it was desired to have at least 36 segments per replicate and an equal sample size in each

replicate. It was determined that a minimum of 108 segments was needed to support publication in areas that were published semiannually and that a minimum of 180 segments was needed for areas that are published bimonthly. The one exception was Baltimore, which received 108 segments but is published bimonthly as part of the Washington–Baltimore CMSA. As the sample size was previously about 10,000 segments and the budget for housing data collection was comparable, multiples of 6 segments were chosen so that the total would be near 10,000 segments.

Sampling housing units. After segments have been chosen for each PSU, housing units are chosen for collection within each segment. Lists of housing units are obtained for each segment and an equal probability sample is chosen. In most cases, the target number of rental units from each segment is five. Prior to sampling, the housing units are ordered by address and the sample taken is systematic, ensuring a geographic spread of housing units selected within the segment. The sampling rate varies from segment to segment, depending on the expected percentage of rental and owned units within the segment.

Collection. Collection includes the screening of the selected housing units to determine if the units are in scope for the housing sample. If the unit is in scope, it is initiated. Initiation is the initial collection of rent data, which consists of the rent paid and the specific housing services that are associated with the unit and the rent paid. These data are the basis for all calculations of rent change that occurs during the life of the unit in the housing sample. After initiation, the housing unit is priced on panel every 6 months. Pricing is very similar to the initiation process, but some previous answers are provided. The collection of the housing data, and particularly the rent data, is independent. That is, the field staff collects the data without giving the respondent the previous answer. Previous answers for some non-rent data are provided, so that the field staff can confirm certain changes with the respondent. Inherent in all of the structured housing questionnaires (screening, initiation, and pricing) are various flow determinations (skip patterns), such that the answer to one question determines the next question that must be asked/answered.

The CADC instrument. The CADC instrument receives the screening/initiation schedules electronically. Even though the schedules have been assigned to specific panels, the field staff has several months to collect the screening/initiation schedules. This is referred to as the non-monthly period. The field staff obtains answers to various (screening) questions (through observation and through direct questioning of eligible respondents) that determine whether an address is in scope for the housing sample. The screening criteria consist of tenure (whether the unit is renter or owner occupied) and other criteria, such as not being in public housing projects, being a primary residence, and the tenant not being a relative of the landlord. With the computer, the skip patterns can be very efficient. Because the computer has stored all of the previously collected data, automated logic checks remove all redundant question patterns, thereby reducing the field staff's work and the respondent's burden. Automated data checking ensures that only correct data types are collected, other automated logic checks ensure that collected data are consistent, and the instrument informs the field staff if any required data have not been collected.

These data checks are being performed at the time of collection, so errors and inconsistencies can be corrected while the respondent is present. The result is that the data that are sent to Washington are as accurate as possible. (The collection instrument also automatically determines appropriate "scope status": permanently out of scope, temporarily out of scope, incomplete, or complete and in scope). If the housing unit is found to be out of scope for some reason that is not likely to change, the collection instrument assigns a scope status of "permanently out of scope" and the unit is never visited again. (An example of this would be units in public housing projects.) If the housing unit is found to be out of scope for some reason that might change, its status is "temporarily out of scope," and another screening/initiation attempt is made after a specified waiting period. (An example of this might be when the unit is not the primary residence for the current tenant, but may become the primary residence for some future tenant.) If the screening was incomplete, the housing unit is assigned a scope status that results in another screening/initiation attempt in 6 months. Selected addresses that pass the screening criteria are considered in scope for the housing sample and are eligible for the next stage of the process, initiation.

Initiation. The CADC instrument automatically moves the interviewer into the initiation portion of the instrument when the instrument has determined that the screening is complete and the housing unit is in scope. As previously mentioned, the collection instrument handles the skip patterns, the automated data and consistency checks, the schedule completion checks, and the final initiation status. The screening and initiation data are then electronically transmitted to the housing database in Washington, DC.

Pricing. During the non-monthly period, the screening/initiation may have occurred off-panel (or not at all). Therefore, the housing units will have to be priced (or perhaps screened/ initiated) on panel. There must be two on-panel prices before the unit can be considered usable. The field staff receives, electronically, the housing units to price from the Washington, DC, database. The CADC collection instrument automatically moves the interviewer into the pricing portion of the instrument and, as mentioned, the collection instrument handles the skip patterns, the automated data and consistency checks, the schedule completion checks, and the final schedule status. The pricing data are electronically transmitted to Washington, where they are reviewed and corrected as necessary. These data, along with the initiation or pricing data from 6 months earlier, are used in the housing pricing relative calculation (PRC) described in the section titled "Estimation of price change for shelter." Occasionally situations occur during pricing that affect the unit's scope status and, on a scheduled but infrequent basis, additional questions are asked to ensure that the housing units are still in scope for the housing sample. If changes occur, the units are treated as indicated in the section titled Initiation, on the basis of their new scope status.

Estimation of price change in the CPI

As stated earlier, the CPI is calculated in two stages. In the first stage, basic indexes are calculated for each of the 8,018 CPI item–area combinations. For example, the electricity index for the Boston CPI area is a basic index. The weights for the first stage come from the sampling frame for the category in the area. Then, at the second stage, aggregate indexes are produced by averaging across subsets of the

8,018 CPI item– area combinations. The aggregate indexes are the higher-level indexes; for example, the all-items index for Boston is the average of all its 211 basic indexes. Similarly, the aggregate index for electricity is the average of the basic indexes for electricity in each of the 38 index areas. The U.S. city average All items CPI is the average of all basic indexes. For the CPI-U and CPI-W, the weights for the second stage are the base period expenditures on the item category/areas from the CE.

2.2.8 Estimation of price change for commodities and services other than shelter

The C&S survey is the CPI's primary source of price change data. Of the 209 C&S item strata, 185 are priced strata. The other 24 C&S strata, all of which have very small weights, are, for a variety of reasons, unsampled or truncated from pricing. The price movements of unsampled strata are imputed from related priced strata. For most priced C&S strata, the C&S survey is the primary source, meaning that information on price change comes from samples that the survey maintains. A few C&S strata, including those for airline fares, intercity train fares, and used vehicles, use secondary sources of data on prices for their samples.

Price relatives. Each month, the processing of the C&S survey data yields a set of price relatives (a price relative is a measure of short term price change) for all basic indexes. The CPI uses an index number formula to obtain an average price change for the items in each basic index's sample. Prior to January 1999, all CPI price relatives used a modified Laspeyres index number formula. This is a ratio of a weighted arithmetic mean of prices in the current period to the same average of the same items' prices in the previous period, with estimated quantities of the items purchased in its sampling period serving as weights. In January 1999, most of the item strata converted to the geometric mean index formula, which is a weighted geometric mean of price ratios (an item's current price divided by its previous price) with weights equal to expenditures on the items in their sampling periods. Calculations for a limited number of strata, including the two shelter strata, continue to use the Laspeyres formula, as shown in the following list:

1. Selected shelter services (rent of primary residence; owners' equivalent rent of primary residence; and housing at school, excluding board).

2. Selected utilities and government charges (electricity; residential water and sewerage maintenance; utility (piped) gas service; State vehicle registration and driver's license).

3. Selected medical care services (physicians' services; hospital services; dental services; services by other medical professionals; and nursing homes and adult day care.)

Since January 1999, most item strata have used an expenditure-share-weighted geometric average ${}_{a,i}R^{G}_{[t;t-1]}$. The other strata use the Laspeyres formula average, ${}_{a,i}R^{G}_{[t;t-1]}$, which all strata used prior to 1999. The Laspeyres is a base-period, quantity-weighted arithmetic average. Every month, the C&S survey system uses the following formulas to compute price relatives for each item–area combination (a,i):

$$ {}_{a,i}R^{G}\ [t;t1] = \pi_{j\epsilon\ a,I}\ \frac{P_{j,t}}{P_{j},t_1}(W_{j,POPS} / \sum_{K\epsilon ai} W_{k,POPS}) , $$

$$ {}_{a,i}R^{L}\ _{[t,t\ 1\}} = \frac{\sum_{je\ a,I}\ (Wj,POPS / P_{J,POPS})\ P_{J;t\ 1}}{\sum_{jeai}\ (W_{j,POPS} / P_{J,POPS})P_{J,t\ 1}} , $$

In these equations,

${}_{a,i}RG\ _{[t;t-1]}$ and ${}_{a,i}R^{L}\ _{[t;t-1]'}$, are, respectively, the geometric and Laspeyres price relatives for area-item combination, a,i, from the previous period, t – 1, (either 1 month or 2 months ago), to the current month,

$P_{j,t}$ is the price of the jth observed item in month t for area-item combination a,

Pj, t-1 is the price of the same item in time t – 1,

Pj, POPS is an estimate of the item j's price in the sampling period when its POPS was conducted, and

The product in the geometric mean formula and sums in the Laspeyres formula are taken over all usable quotes in area-item combination a,i. It is important that the price of each quote be collected (or estimated) in both months in order to measure price change.

Quote weights. For each individual quote, the weight Wj, POPS is computed as

Wj, POPS = AEfgη / BN, where

A is the proportion of the total dollar volume of sales for the ELI relative to the entire POPS category within the outlet (called the outlet's percent of POPS for the ELI),

E is an estimate of the total daily expenditure for the POPS category in the PSU by people in the U-population (called the basic weight),

f is a duplication factor that accounts for any special subsampling of outlets and quotes,

g is a geographic factor used to account for differences in the index area's coverage when the CPI is changing from an area design based on an old decennial census to a design based on a more recent census,

η is the number of planned quotes for collection in the ELI – PSU, which is also the sum of duplication factors for all quotes in the ELI – PSU;

y is the sum of duplication factors for uninitiated quotes in an ELI – PSU;

N is 1 + (y / (N – y)), which is essentially the ratio of planned quotes to quotes with usable prices in both periods t – 1 and t for the ELI – PSU; and

B is the proportion of the item stratum's expenditure accounted for by the ELI in the region.

POPS - period prices. In the Laspeyres formula, the item expenditure weight is divided by an estimate of the item's price in the sampling period to convert the expenditure into an estimated quantity. An item's POPS period occurred sometime before its outlet's initiation, so that one cannot observe its POPS price directly. Instead the price is estimated from the item's price at the time the sample was initiated and the best estimates of price change for the period from the POPS period to the initiation period. The formula is :

Pj, POPS = Pj , 0 / [IXj,0 / IXj, POPS],

where

Pj,0 is the price of the jth item at time 0 (when it was initiated or chosen for the sample),

IXj,0 is the value of the price index most appropriate for the jth item in period 0, the time it was initiated, and

IXj, pops is the value of the same price index in the POPS period POPS).

Item replacement and quality adjustment

One of the more difficult problems faced in compiling a price index is the accurate measurement and treatment of quality change due to changing product specifications and consumption patterns. The concept of the CPI requires a measurement through time of the cost of purchasing an unchanging, constant-quality set of goods and services. In reality, products disappear, products are replaced with new versions, and new products emerge.

When the data collector finds that he or she can no longer obtain a price for an item in the CPI sample (most commonly because the outlet permanently stops selling it), the data collector uses the CPI replacement procedure to find a new item. As explained earlier in the section on CPI item and outlet samples, each item stratum consists of one or more ELIs. CPI staff economists, called commodity analysts, in Washington, DC, have developed checklists that define further subdivisions of each ELI. When seeking a replacement in a retail outlet, the data collector first uses the checklist for the ELI to find the item the outlet sells that is "closest" to the previously priced one. Then the data collector describes the replacement item on the checklist, capturing its important specifications. The commodity analyst assigned to the ELI reviews all replacements and selects 1 of 3 methods to adjust for quality change and to account for the change in item specifications.

The following example describes the most common type of quality adjustment problem. Assume that in period t a data collector tries to collect the price for item j in its assigned outlet and is not able to do so because the outlet no longer sells the item. A price for item j was collected in period t – 1. Following the

procedure, the data collector finds a replacement and collects a price for it. The replacement becomes the new version (version v + 1) of item j. The decision as to how the CPI treats the replacement is made by the commodity analyst assigned to the ELI to which item j belongs. The commodity analyst has the descriptions of the two versions of item j. In addition, he or she has the t – 1 price, Pv j, t-1, for the earlier version (version v) and the period t price, Pv+1 j, t, of the replacement version v + 1. The following matrix displays the price information available to the commodity analyst:

Version	Period t-1 price	Period t price
Old version v	$P^{v}_{j,t-1}$	---
Replacement version V+1	---	$P^{v+1}_{j,t}$

To use the item in index calculation for period t, we need an estimate of Pv+1 j,t-1, the price of the replacement version, v + 1, in period t – 1, or we need an estimate of Pv j,t, the earlier version v, in period t. If there is no accepted way of estimating either Pv+1 j,t-1 or Pv j,t, the observation for item j is left out of index calculation for period t, meaning that the observation is treated as a nonresponse handled by imputation (described shortly).

The commodity analyst chooses 1 of 3 methods to handle the replacement

- Direct comparison
- Direct quality adjustment
- Imputation

Direct comparison. If the new and old items are essentially the same, the commodity analyst deems them directly comparable, and the price comparison between the items is used in the index. In this case, it is assumed that no quality difference exists.

Direct quality adjustment. The most explicit method for dealing with a replacement item is to estimate the value of the differences. The estimate of this value is called a quality adjustment amount QAj, t-1 . In this case,

$$Pv+1\ j,\ t-1 = Pv\ j,\ t-1 + QAj,\ t-1.$$

Chief sources of direct quality adjustment information are manufacturers' cost data and hedonic regression.

Imputation. Imputation is a procedure for handling missing information. The CPI uses imputation for a number of cases, including refusals, inability to collect data for some other reason (the item may be out of season), and the inability to make a satisfactory estimate of the quality change. Substitute items that can be neither directly compared nor quality adjusted are called non-comparable. For non-comparable

substitutions, an estimate of constant-quality price change is made by imputation. There are two imputation methods: Cell-relative imputation and class-mean imputation.

Cell-relative imputation. If there is no reason to believe that price change for an item is different from those for the other items in its cell or basic index, the cell-relative method is the appropriate way to impute. This method is used for missing values because in that case we have no knowledge about the observation. For non-comparable substitutions, the cell-relative method is prevalent for food and service items. The price change between the old item and the non-comparable new item is assumed to be the same as the average price change of all similar items in 1 month for the same geographic area—that is, the same as the average price change for the cell for that ELI and PSU.

In this method, which is sometimes referred to as "linking," the item is effectively left out of the calculation for 1 month; the cell relative is computed without the observation. The price relative (either $R^{L}_{ai,t,t-1}$ or $R^{G}_{a1,t,t-1}$) is computed with one less useable quote.

When there is a new version of the item that is not comparable to the previous version, a price of the new version ($^{Pv+1}_{j,t}$) is available. That price is not used in the calculations for period t but, in the subsequent period $P^{v+1}_{j,t'}$ is used as the previous price. If, on the other hand, the reason for the imputation was that the item was temporarily missing (meaning that no price was collected), a period-t price must be estimated. For this purpose, the cell relative is used to estimate the period-t price:

$$Pv\ j,\ t = Rai,\ t,\ t - 1 \times Pv\ j,\ t - 1.$$

Class-mean imputation. The C&S uses class-mean imputation for many non-comparable replacements, primarily in the item strata for vehicles, for other durables including high tech items, and for apparel. The logic behind the class-mean procedure is that, for many items, price change is closely associated with the annual or periodic introduction of new lines or models. For example, at the introduction of new model year vehicles, there are often price increases while, later in the model year, price decreases are common. The CPI uses the quality adjustment method as frequently as possible to handle item replacements that occur when vehicle product lines are updated. Class-mean imputation is employed in the remaining replacement situations. In those cases the CPI estimates price change from the price changes of other observations that are going through item replacement at the same time and were either quality adjusted directly or were judged directly comparable. For class-mean imputation, the CPI estimates Pv j, t, which is an estimate of the current (t) price for the old version (v), and uses this estimated current price in the calculation of the price relative for period t. The estimated current-period price is the previous-period (t – 1) price of the old version times a specially constructed price relative for the class:

$$Pv\ j,\ t\ =\ Pj,\ t - 1 \times cR\ [\ t;\ t - 1].$$

cR [t; t - 1] is computed with either the geometric mean or Laspeyres formula over the subset of observations in the ELI to which item j belongs. The subset is the class of interest—that is, all the comparable and quality-adjusted replacement observations in the same ELI and PSU.

Review and treatment of outlier price changes. All outlier price changes are reviewed by commodity experts. Outlier price changes, if accurate, are generally included in the calculation of price relatives. Extreme price changes are bounded, as the geometric mean formula performs poorly for zero and near-zero prices.

Estimation of price change for shelter. The rent and OER indexes measure the change in the cost of shelter for renters and owners, respectively. Price change 21 data for these two indexes come from the CPI housing survey. Each month, BLS economic assistants gather information from renter units on the rent for the current month and on what services are provided.

Rent. The rent estimates used in the CPI are "contract rents." They are the payment for all services the landlord provides in exchange for the rent. For example, if the landlord provides electricity, it is part of the contract rent. The CPI item expenditure weights also include the full contract rent payment. The CPI rents are calculated as the amounts the tenants pay their landlords plus any rent reductions tenants receive for performing services for the landlord (sometimes called "rent as pay") plus any subsidy payment paid to the landlord. Reductions for any other reasons are not considered part of the rent.

Owners' equivalent rent (OER). The OER approach to measuring price change for owner-occupied housing started in the CPI-U in January 1983 and the CPI-W in January 1985. The OER index is designed to measure the change in the rental value of owner-occupied housing. In essence, OER measures the change in the amount a homeowner would pay to rent, or would earn from renting, his or her home in a competitive market. It is a measure of the change in the price of the shelter service provided by owner-occupied housing.

PRC for Housing. The housing and the C&S systems do not directly calculate indexes. Instead, they produce price relatives, and the index estimation system then uses the price relatives for basic index calculation. Price relatives are ratios of price change from the previous month (t – 1) to the current month (t), and basic index calculation updates the last month's indexes (t – 1) to the current month (t).

Weighting during the PRC. Each calculation begins with a segment weight (Ws) based on the probability of selecting the segment. (See earlier section titled "Weighting during segment sample selection.") To derive the renter weight in the segment (RWs), the segment weight (Ws) is multiplied by the number of renters in the segment, divided by the number of renters sampled in the segment: Similarly, the owners' equivalent rents weight (OWs) is derived by multiplying the segment weight (Ws) by the number of owners in the segment divided by the number of renters sampled in the segment.

$$RW_S = W_S \times \frac{R_S}{n_S},$$

Similarly, the owner's equivalent rents weight (OW) is derived by multiplying the segment weight (W_S) by the number of owners in the segment divided by the number of renters sampled in the segment. Because the housing survey collects rents and not the implicit rents of owners, the ratio of average implicit rent to average rent in the segment is also included in the owner's equivalent rent weight:

$$OW_S = W_S \times \frac{O_S}{n_S} \times \frac{IR_S}{RR_S}.$$

The rent and OER estimators. The rent estimator uses the change in the "economic rent," which is basically the "contract rent" adjusted for any changes in the quality of the housing unit. The OER estimator uses the change in the "pure rent," which excludes the cost of any utilities included in the rent contract.

The 6-month chained estimator. For the rent index, the current month's index is derived by applying the sixth root of the 6-month rent change to the index for the previous month. For the OER index, the current month's index is derived by applying the sixth root of the 6-month OER change to the index for the previous month. The rent estimator uses the change in the "economic rent." Because of the panel structure used in the housing sample, the 6-month change in rent is based on sampled, renter-occupied units that have usable 6-month rent changes. The sum of the current (t) economic rents for each usable unit within a segment, weighted by the renter weight for that segment, is divided by the sum of the weighted economic rents six months earlier (t – 6). This ratio is used to represent the 6-month change in rent for all renter-occupied units in the segment.

In a parallel calculation, the sum of the current (t) pure rents for sampled, renter-occupied units within a segment, weighted by the owner weights, is divided by the sum of the weighted pure rents six months earlier (t – 6). This ratio is used to represent the 6-month change in the OER index for all owner-occupied units in the segment. The functions of the PRC have been designed to make use of the parallel rent and OER computations. In general, the PRC aggregates the weighted rents for the units (i) in the Index Area (a) for the current period (t) and for 6 months previous (t – 6). When the PRC is run for rent, economic rents (ERi) and renter weights (RWs) are used:

$$REL_{t-6,t,a}^{RENT} = \frac{\sum_{i \epsilon a} RW_S \times ER_{i,t}}{\sum_{i \epsilon a} RW_S \times ER_{i,t-6}}$$

When the PRC is run for OER, pure rents (PRi) and owner weights (OWs) are used. That is,

$$REL_{t-6,t,a}^{OER} = \frac{\sum_{i \epsilon A} OW_S \times PR}{\sum_{I \epsilon A} OW_S \times PR_{i,t-6}}$$

The index estimation system needs a 1-month price relative, not a 6-month price relative; therefore, the 6th root of the REL_{t-6},t,a is derived:

$$REL_{t-1,t,a} = \sqrt[6]{REL_{t-6,t,a}}$$

and then passed to the index estimation system for basic index computation for the rent and OER item strata.

Vacancy imputation: Vacant units that were previously occupied by renters are used in the calculation of Rt,t-1 and Rt,t-6 . The vacancy imputation process incorporates several assumptions about the unobserved rents of vacant units. It is assumed that rents tend to change at a different rate for units that become vacant (and are, therefore, in the process of changing tenants) than for other units. The vacancy imputation model assumes that, after an initial lease period, expected rents change at a steady rate until the old tenant moves out of the unit. When there is a change in occupant or a unit becomes vacant, the rent is assumed to jump at some rate, referred to as the "jump rate." In markets with generally rising rents, this jump rate is usually greater than the average rate of change for occupied units. BLS estimates the jump rate based on non-vacant sample units in the PSU that have had a change in tenant between t – 6 and t. Rent changes for non-vacant units without a tenant change are used to calculate the average continuous rate of change. These values are used to impute rents for vacant units for period t from their rent in t – 6.27 The imputed rent, ri,t of the ith vacant rental unit in t is

$R_{i,t}$, = $r_{i,t-1}$ J if the unit was not vacant in t – 6 or

$R_{i,t}$,t = $r_{i,t-1}$ C6 if the unit was vacant in t – 6,

where J is the 6-month jump rate calculated for the PSU, and C is the 1-month steady rate of change.

The imputation of vacant rents ensures that the unobserved rent change that occurs when a unit becomes vacant is reflected in the final rent index. The 6-month rent-change estimates capture these changes once the units become occupied.

Non-interview imputations. Units that were previously responding, not currently responding, and are not vacant are also imputed and used in the calculation of Rt,t-1 and Rt,t-6 . All units within a PSU are broken up into high, medium, and low rent categories based on their rent level in t – 6. The rents of non-responding, non-vacant units are imputed forward into t by using the average rent change of other housing units in their respective category.

Aging adjustment. The aging adjustment accounts for the small loss in quality as housing units age (or depreciate) between interviews. The aging adjustment factors can be thought of as 1/(1 – d) where d is the monthly rate of physical depreciation. BLS computes factors for each housing unit with regression-based formulas. The formulas account for the age of the unit and a number of structural characteristics. The aging adjustment procedure was introduced into the CPI in 1988.

2.2.9 Special pricing and estimation procedures for medical care

Although third parties (mainly government agencies and employers) pay much of the cost of medical care on behalf of consumers, the medical care component of the CPI covers only that part of healthcare commodities, services and health insurance premiums that consumers pay for "out of pocket." Medical insurance premiums constitute the largest part of consumers' out-of-pocket spending for medical care. Unlike other forms of consumer insurance in the CPI, the data needed from insurers to hold the quality of the insurance policies constant are so extensive and so closely held that BLS has not been able to construct a constant-quality health insurance index. Consequently, the CPI has employed an indirect method for pricing health insurance. In short, the CPI allocates most of consumers' out-of-pocket expenditures on health insurance premiums to the weights for other healthcare services and commodities, placing the small remainder, which covers the insurance companies' costs and their profits, into a separate stratum.

Use of the indirect method for pricing health insurance has two important effects on the CPI. First, the relative shares of the weights for most of the other CPI medical care item strata are increased, because they include their portions of the reallocated consumer expenditure for health insurance premiums.30 Second, the CPI approach to measuring price change for medical care items reflects the fact that these items are, for the most part, paid for by insurance companies and, therefore, the approach must take account of insurance arrangements such as type of reimbursement method.

Medical care items and their prices. The movement of CPI medical care indexes is based on the average change in the prices of a sample of items selected to represent them. The items are, for example, a prescription for a specific medicine or a visit of a specified duration to a doctor or a hospital. These are inputs to medical treatments addressing a specific medical condition. The CPI data collectors, following CPI sampling procedures, select the sample items by working with respondents in pharmacies, doctors; offices, hospitals, and other outlets that provide medical care.

The CPI defines the transaction price for medical care as all payments or expected payments received from eligible payers, including both the patient and appropriate insurers. In most cases, the field staff is able to collect transaction prices; if the respondent is unable or unwilling to provide transaction prices, then cash or self-pay prices are collected, except in the case of hospitals where :list prices," or so called charge master prices, are normally not collected unless associated with a self-pay patient.

CPI medical care indexes. The CPI medical care aggregate index covers medical care commodities, which consist of prescription and over-the-counter (OTC) drugs and supplies, and medical care services, which include professional services, hospital services, and medical insurance. The professional medical services expenditure category serves as the umbrella for a series of stratum indexes: Physicians' services, dental care, eye care, and services by other medical professionals. The hospital and related services category includes item strata for hospital services, nursing home services, and adult day care. Medical insurance, for which the weight share is reduced due to indirect pricing, is the remainder of the medical care services category. Details on the more difficult pricing issues associated with these item strata follow.

Prescription drugs. In response to technological change and the complex marketing of prescription drugs, the CPI program has developed a series of techniques to show the effects of such trends. Field staff uses special procedures to handle the expiration of a drug's patent protection and the subsequent introduction of equivalent generic drugs, a prescription drug's conversion to OTC status, and the introduction of new pharmaceutical products into the market place.

Brand vs. generic. Since 1995, a method has been in place allowing generic versions of prescription drugs coming off patent to have a chance for inclusion in the CPI. Typically, 6 months after the expiration of the patent for a particular prescription drug, the CPI economic assistant (data collector) disaggregates among all the FDA-designated therapeutically equivalent versions of the medicine, including the brand name, that are available in each outlet in which the original drug is priced. This process allows the newer generics an opportunity to build sales in the individual pharmacy over a 6-month period, and then, through disaggregation, a probability-proportional-to-size statistical technique, the generic versions of the drug have a one-time chance for selection in proportion to sales volume at the particular outlet. Should a generic drug be selected, any price change that occurred from brand to generic is reflected in the index.

Prescription vs. over the counter. When a drug in the CPI's prescription sample loses its prescription status and is sold as an OTC drug, the CPI retains the item as part of the prescription drug sample while using its OTC price. Thus, the prescription drug index series shows any price change that occurs as a result of drugs changing status from prescription to OTC. The OTC version of the drug remains in the prescription drug sample until it rotates out during the next rotation scheduled for that item. Generally, each sample rotates every 4 years. At future sample rotations, the OTC item is eligible for initiation in the nonprescription drug stratum and ineligible in the prescription drug stratum. Similarly, should a drug in the nonprescription sample change its status (that is, from OTC to prescription), the CPI would show the resulting price change, if any, in the nonprescription drugs and supplies index.

Physicians' services. This item stratum covers services that are performed and billed by private-practice medical doctors. This includes all medical professionals with a Doctor of Medicine (M.D.) degree except for ophthalmologists, whose services are priced in the eye care stratum. It also includes osteopaths (they are not MDs, but often have hospital privileges). House, office, clinic, and hospital visits are included as long as the bill comes from the physician.32 At initiation of a quote for physicians' services, the CPI data collector first establishes the practitioner's specialty and then disaggregates to an appropriate service. The data collector describes the characteristics of the selected visit and any related procedures using a CPI checklist specific to the medical specialty. Current Procedural Terminology (CPT) codes are used to help describe the item precisely; this description remains fixed for the 4 years during which the CPI program follows its price, unless either the selected combination of services changes or a CPT code definition is modified. Transaction prices in the physicians' services index may include Medicare Part B payments, as well as those fees that the doctor expects to receive directly from the patient or from private insurance.

Services by other medical professionals. This stratum covers services performed and billed by medical practitioners who are not Medical Doctors (lack an M.D. degree) and are not covered in the dental

stratum or the eye care stratum. Included here are chiropractic and physical therapy, podiatry, audiology (including hearing aids), acupuncture, nursing, nutritional counseling, occupational therapy, and psychology and psychotherapy.

Hospital services. Items in the hospital services stratum cover the hospital portion of a medical treatment, including inpatient and outpatient services. The pricing unit is the hospital visit, defined by a date of admission and a date of discharge as documented on a hospital bill and usually associated with a specific diagnosis or medical condition.33 At initiation, the CPI data collector works with the respondent to select a hospital bill based on revenues generated by eligible payers. The data collector refers to the bill to describe the item in terms of the bundle of goods and services consumed during a time frame or visit for the purpose of bringing the patient to the physical (or mental) state required for discharge from the hospital. The form that the hospital visit takes as the pricing unit is that of its reimbursement method, the method used by the insurer to pay the hospital for the services. There are several possible types of reimbursement that insurers may write into their contracts with providers: Fee-for-service, diagnosis related group, per diem, case rate, admission rate, package, ambulatory patient group, service units, and capitation. With the exceptions of fee-for-service and fee schedule, each type of reimbursement reflects either a lump-sum payment based on the diagnosis or type of procedure performed or a flat fee per unit of service.

Current procedures for selecting hospital services to price in the CPI involve the following basic steps:

• Disaggregation by setting to reflect the relative proportions of inpatient services versus outpatient services at the individual hospital outlet level

• Disaggregation by payer (for example, self-pay or insurance company)

• Selection of hospital bills based on selected payers, when the hospital administration will provide them

• Request for the type of reimbursement method and the actual or estimated payment for the described hospital visit, based on the terms of the contract between the provider and the insurer

• Description of the hospital visit, including a bundle of procedures, services, equipment use, supplies, and materials typically associated with the hospital event or episode, as defined by both the bill and the contract (the visit).

Monthly pricing and bimonthly pricing consist of updating the reimbursement method and amount based on the contract between provider and insurer, and maintaining current discounts and (for those fee-for-service reimbursements based on the hospital charge master with applied discounts) list prices.

Health insurance. As previously noted, the CPI employs an indirect method to measure price change for health insurance. This indirect approach decomposes medical insurance into three parts:

1. Changes in the prices of medical care items covered by health insurance policies

2. Changes in the cost of administering the policies

3. Changes in the cost of maintaining reserves and, as appropriate, profits

Most of the expenditure for health insurance goes for the first item—the part that reflects the insurers' payments for medical treatment. The CPI program allocates this part of health insurance spending to the medical care indexes for those treatments in proportion to claims paid out for them. The remaining weight for the other two parts of insurance is for the overhead of the insurers; this is all that remains in the CPI health insurance index. Note that it is only consumer-paid insurance that is in scope; out-of-scope or ineligible health insurance receipts include those from employers, Medicare Part A (funded through payroll taxes), Medicaid, and workers' compensation.

Price movement over time for the health insurance index in the CPI is determined by the movements of the other medical care strata, adjusted by changes in the retained earnings ratio. (See subsection titled "Retained earnings ratio.") This process yields a measure of price change for insurance of constant coverage and utilization. That is, changes in benefit coverage and utilization levels generally are offset by compensating premium charges and thus do not significantly affect retention rates. Implicit in the process is the assumption that the level of service from the individual carriers is strictly a function of the benefits paid. Other changes in the amount of service provided for policyholders, such as more convenient claims handling, affect the movement of the index even though, strictly speaking, they should be removed; still, the effects are probably small.

Retained earnings ratio. BLS obtains calendar year data for premium income, benefit payments, and retained earnings. For each year, the ratio of retained earnings to benefit payments is calculated, yielding a retained earnings ratio. The latest year's ratio is divided by the previous year's ratio to obtain the annual relative of change in the ratios. This annual relative of change is converted to a monthly relative (taking its 12th root) so the CPI can reflect the change month by month over the calendar year. Because it is not feasible to obtain the monthly change in price caused by changing retention margins, spreading the annual change evenly over the year is preferable to reflecting the entire annual change in one month.

2.2.10 Special pricing for other items

New vehicles. Prices for new cars and trucks, selected for inclusion in the CPI, pose a special problem because the manufacturer's suggested retail (sticker) price is not the transaction price for most new vehicles. Most automotive dealers offer customers concessions on the sticker price or, for models that are in high demand, the dealers charge an additional markup beyond the sticker price. When collecting the price of new vehicles, BLS economic assistants record all of the components of the sticker price separately. This includes the base price and the prices for options, dealer preparation, transportation, and so forth. In addition, they obtain from the dealer the average rebate, concession, and/or markup during the preceding 30 days. This enables BLS to estimate the true transaction price.

Quality adjustment is also common in calculation of the new vehicles index. The most frequently cited example of direct quality adjustment in the CPI deals with the annual model changeover for new cars

and trucks. Each year, price adjustments are made to account for the quality differences between the old and the new models. In some cases, the adjustments are based on the previous model's retail price for optional equipment. In other cases, the quality adjustments must be derived from production cost data supplied by the manufacturers. These data are adjusted by estimated manufacturer and retailer markup rates to derive retail values for the quality changes.

Adjustments for quality change in the CPI new car index include structural and engineering changes that affect safety, reliability, performance, durability, fuel economy, carrying capacity, maneuverability, comfort , and convenience. Since 1999, quality adjustments have not been made for changes associated with pollution control mandates.

The derivation of production cost-based quality adjustments for new cars is carried out in association with the BLS Producer Price Index and International Price programs. The adjustments exclude changes in style or appearance, such as chrome trim, unless these features have been offered as options and purchased by customers. Also, new technology sometimes results in better quality at the same or reduced cost. Usually, no satisfactory value can be developed for such a change. In such cases, the quality change is ignored, and prices are compared directly.

In addition to quality adjustments for physical changes to cars and trucks, adjustments are made for changes in the warranty coverage provided by auto manufacturers when sufficient data are available to derive estimates of their values.

Vehicle leasing. The vehicle leasing index was first published by BLS in January 2002. The prices used in the index are monthly lease payments. As with new vehicles, the agreed upon purchase price of the vehicle must be estimated. BLS economic assistants collect the base price and the prices for options, dealer preparation, transportation, and so forth. Also, any rebates available are included, along with the largest estimated concession or discount the dealer would allow for the leased vehicle on the day of pricing. Then, the lease terms are applied to obtain the residual value, depreciation amount, rent charge, and the total monthly lease payment. During the annual model changeover, the quality adjustments developed for the CPI new car index are also used in the CPI vehicle leasing index.

Used cars and trucks. Models that are from 2- to 7- years-old are priced in the used car and truck index. Data on used vehicle prices are obtained from a secondary source. Once a year, each sample vehicle is updated by one model year to maintain the same age vehicle. The sample prices are adjusted for quality change by applying the same information used for quality adjustment in the new vehicle index. This is done by figuring the percentage that the quality adjustments represent of the price of the vehicle when it was new. The quality adjustments are then assumed to depreciate at the same rate as the car as a whole.

Apparel. The special characteristics of apparel marketing have historically caused a number of problems in the maintenance of a constant-quality market basket of apparel in the CPI. Many apparel items are seasonal and inventory is constantly fluctuating in reaction to changing fashions. In addition, large price changes are common as marketing practices for apparel generally entail introducing such goods at high regular prices and discounting to lower sale prices throughout their product lifecycle. When an outlet

discontinues an apparel item, the BLS economic assistant follows the CPI substitution procedures to find the closest substitute that the outlet offers for sale. These procedures are developed by applying the results of hedonic regression models and ensure that the economic assistant matches many of the price-determining quality characteristics between the substitute and discontinued items.

Hedonic regression modeling is the technique used to determine the importance of the price-determining quality characteristics that add or subtract value to a particular good. In this approach, an item can be viewed as a collection of characteristics that, taken together, provide satisfaction or value to the consumer. For example, a woman's suit can be considered an aggregation of its components, such as a jacket and skirt or pants, each of which contributes value to the suit in the eyes of the consumer. In addition, characteristics of the suit, such as its fiber content and its construction, add or subtract value from the consumer's standpoint. Hedonic regression modeling is a tool that allows commodity analysts to estimate which characteristics are price determining, and how these estimates influence the direction and magnitude of a good's price. This research has resulted in improved data collection documents and procedures for pricing apparel commodities. By noting the most important quality characteristics on data collection documents, economic assistants who collect data for the CPI can hold price determining characteristics constant when pricing seasonal and fluctuating inventories. This improvement in data collection documents has enhanced the reliability of apparel price estimation, since it increases the number of direct price comparisons or sample observations that can be used for index calculations.

When the economic assistant must substitute to a new good or item because the previously priced item is no longer available in the retail outlet, the commodity analyst determines whether the items are comparable, non-comparable, or can be quality-adjusted by means of applying characteristic estimates developed in a hedonic regression model. For comparable items the price of the new item is directly compared to the price of the old item and the price change or relative is used for index estimation. For non-comparable items the price change for the item is imputed via the class-mean imputation method. For quality adjustments the price of the discontinued item is adjusted based on the difference in characteristics between the discontinued and substitute items using the characteristics value estimates developed in the hedonic regression model for the apparel item. For example, if a two-piece men's suit was priced in the apparel price sample and is now no longer available in the outlet, because the retailer will only stock three-piece suits instead of two-piece suits, the value of a vest included with a three-piece suit can be added to the price of the old two-piece suit using the hedonic price estimate for the vest and the quality-adjusted price of the old two-piece suit can be reliably compared directly with the price of the new three-piece suit for a constant quality measure of price change. Alternatively, if fiber percentages vary between two items, quality adjustment can account for the characteristic difference to permit constant quality comparison of the prices of the two goods.

Other characteristic differences that have been found to be statistically significant also have been factored out to permit constant-quality price comparisons for apparel items. Hedonic quality adjustments have played a significant role in increasing the number of constant quality price changes that can be used for index calculations by accounting for differences in quality characteristics when substitutions occur.

Natural gas. To measure a constant consumption amount for the CPI's utility (piped) gas service index, the data collector initiates a fixed level of energy or heat consumption for each observation. The fixed consumption amount is selected in Washington, based on household bill expenditure data as reported in the CE. Subsequently, when the observation is priced each month, field staff collects the cost of that fixed amount. This amount is defined as a fixed number of therms (a therm is 100,000 British Thermal Units, or BTUs). When the surveyed outlet delivers and bills its residential customers by the number of therms consumed, the CPI uses the current price per therm to determine the prices of that outlet's observations. But, when piped gas is delivered and billed by volume (for example, cubic feet), the CPI program must adjust each quote to account for the fact that the volume of gas needed to produce a constant amount of energy or BTUs varies, depending on the quality of gas (BTUs/CF). In this case, the amount of gas priced each month is adjusted based on the heat value of gas delivered by the outlet as follows:

Current adjusted consumption = original consumption × (original heat value/current heat value).

This adjustment ensures that a constant amount of energy is being priced from month to month for the utility (piped) gas service index.

Special pricing for seasonal items. Seasonal items are those commodities and services that are available only at certain times of the year rather than year round. Down parkas, snow skis, and fresh tangelos are examples of seasonal items. Special procedures are employed when selecting and pricing items generally available only part of the year to ensure that they are appropriately represented in the sample and that price changes are correctly included in the calculation of the CPI. In particular, the procedures prevent substituting away from a seasonal item when it is out of season. Although seasonal items can exist in any ELI, some ELIs include an especially large percentage of such items and, consequently, receive special treatment. These seasonal ELIs include most apparel items, fresh fruit, indoor plants and cut flowers, fans and air-conditioners, some sports and recreational equipment, and admission to sporting events. The designation of an ELI as seasonal or non-seasonal is made at the regional level, using the four geographic census regions in the CPI design. Some items that exhibit a seasonal selling pattern in the Northeast region, for example, may be sold year round in the South. In practice, though, nearly all ELIs designated seasonal are seasonal in all four regions.

After the samples for these seasonal ELIs are selected following the normal sample selection procedures, the number of quotes is doubled to ensure that, despite the seasonal disappearance of a substantial number of quotes, a large enough number of in-season quotes remains to calculate the index. The quotes in these ELIs are paired; that is, for each original quote that is selected, a second quote in the same ELI and outlet is initiated and priced 6 months later. In the fresh fruit ELIs, one quote of each pair is designated January–June, and the other quote is designated July-December. In all other seasonal ELIs, one quote of each pair is designated fall/winter, and one quote is designated spring/summer. The fall/winter and spring/summer designations are used for the nonfood quotes because these are the distinctions that are most commonly used by the retailing industry to categorize seasonal merchandise. These seasonal designations are used to help establish the specific items eligible

for each quote so that year-round items and items from each season are initiated in their proper proportions.

Economic assistants attempt to price every item in each period during which it is designated for collection, even during those months when the item may be out of its indicated season. If the item is available, the price is collected and used in the calculation of the CPI. A common practice in marketing seasonal items, particularly seasonal clothing, is to mark down prices to clear the merchandise from the stores as the end of each season approaches. During the period when a seasonal item is unavailable, its price is imputed following standard imputation procedures. When an item returns at the beginning of its season several months later, the price is directly compared with the item's last price, as it has been imputed forward. This completes the circle in a sense: having followed the price of the item down to clearance price levels, BLS then follows the price back up to regular (or at least higher) prices the following season. Keep in mind that, in this context, the "following" season means the same season the next year; that is, the following fall/winter season for the fall/ winter sample, and the following spring/summer season for the spring/summer sample.

When an item becomes permanently unavailable, the standard procedure is to substitute the most similar item sold in the outlet. In the case of a year-round item not in a seasonal ELI, this process takes place as soon as the item is permanently unavailable. For items in seasonal ELIs and seasonal items in ELIs that are not designated seasonal, however, the period during which a substitution can take place is restricted to those months when a full selection of appropriate seasonal merchandise is available. These special initiation, pricing, and substitution procedures are intended to ensure that an adequate sample of items is available every month, and that the correct balance of seasonal and year-round items is maintained. As a result, the estimates of price movement for the ELIs that include seasonal items correctly reflect price changes not just for items available year round but for the entire universe of items included in those ELIs.

2.2.11 Other price adjustments and procedures.

Bonus merchandise adjustments. Sometimes, products are offered with free merchandise included with the purchase of the original item. Such "bonus" items may provide additional satisfaction to consumers, and BLS will, therefore, make adjustments to the purchase price to take into consideration the value of the bonus merchandise. The adjustment made depends on the type of merchandise offered and the perceived value of the bonus to the consumer. If the bonus merchandise consists of more of the same item, the adjustment is reflected in the price of the item. For example, if a manufacturer offers two ounces of toothpaste "free with the purchase of the regular 6-ounce tube," the item's price is adjusted to reflect a decrease in the per ounce price. When the bonus is removed, the price per ounce returns to its previous level, and a price increase is recorded. In this instance, the value to the consumer is assumed to be one-third greater during the bonus period. If the bonus merchandise consists of an item that has some significant value to the consumer, and the item is of a different genre, an adjustment is made to account for the value of the free item when it is feasible to do so. Bonuses that are contingent on an additional unrelated purchase, such as a free can of soup when purchasing a whole chicken from the poultry case, are ignored.

Cents-off coupons. For a coupon to be used to reduce the reported price of an item, the coupon must be either attached to the item, attached to the product's display shelf, dispensed by machines attached to the product's display shelf, located at promotional displays, or distributed to all shoppers by product representatives standing in the immediate vicinity of the display shelf. All other coupons presented by customers as purchase reductions at the time of payment are ineligible.

Concessions. A concession is a deduction of a specific amount from the proposed selling price for the item. The usual CPI practice is to subtract from the proposed selling price the average concession for the priced item over the past 30 days.

Different day pricing. For a subset of items, if the selected priced item is not available for sale at the time of collection, prices from up to seven days prior to the actual day of collection are eligible. The item must have been offered for sale during the previous 7 days and the most recently available price is reported. The list of items eligible generally consists of specific items that may not be available every day, such as a specific type of fresh fish.

Discounts. A discount price is a reduced price that is available to only certain customers in a specific outlet. If the discount is available only during the period of price collection, such as that for a grocery-card discounted item, the discount is included only if 50 percent or more of sales for the affected item are discounted. If the discount is in effect for more than one collection period and the discount applies to 5 percent or more of the dollar sales of the item in the outlet, a probability selection is made to determine if the discount should be collected. For example, if the regular cash price accounts for 84 percent of sales, senior citizens' discounts account for 10 percent and employee discounts account for 6 percent of sales, a one-time probability-based selection is made among the three options to determine which price to report.

Manufacturers' rebates. When product manufacturers offer customers cash rebates at the time of purchase for purchases of items priced in the CPI, these rebates are reflected in the index as price reductions. When a rebate is 28 offered for a priced new vehicle, it is the estimated average rebate over the past 30 days that is subtracted from the vehicle's reported price. For vehicle leasing, it is the rebate in effect as of the day the collected price is obtained. For mail-in rebate offers, the price of the affected item is reported without subtracting the amount of the rebate. An attempt is made to determine the proportion of customers who take advantage of the rebate, and prior to use in the index, the reported price is then adjusted accordingly.

Membership retail outlets. Outlets that require a membership fee to be paid in order to be able to shop at the outlet are eligible for pricing in the CPI. If the actual price paid for products varies with the level of membership, a specific membership is selected and the reported prices reflect that membership level.

Quantity discounts. Many items in the CPI are sold both individually and in quantity. When consumers are able to purchase an amount greater than a single unit at a discounted price, the first multiple-unit price is reported for use in the CPI. For example, if the 12-ounce can of corn being priced can be purchased at 25 cents for a single can, three cans for 69 cents, or five cans for $1, the price used in the CPI will be the per ounce price of the three cans.

Shoppers' cards. If a priced outlet issues a card offering a "card discount" on selected products purchased by cardholders, such discounts are treated as "temporary discounts" and processed as follows. The discount is included only if 50 percent or more of sales for the affected item during the collection period are subject to the card discount.

Special-day prices. If a selected outlet has different prices for priced items based on the day of the week when a purchase is made, a selection is made between special-day and regular-day purchases, based on revenue. If the "special day" is selected, the price collected is for the most recent special-day price.

Utility refunds. Sometimes, public utility commissions require that utilities such as telephone, natural (piped) gas, or electricity companies make rebates to their customers. These rebates may arise from a number of different causes. For example, a utility may be permitted to use a new rate schedule temporarily until a final determination is made. If the final rates set by the commission are lower than the temporary ones, the difference must be refunded for consumption during the period. The CPI does not always view such refunds as reflecting current period prices for utility services. If all customers, both new and existing, are subject to having the refund applied to their bill, then the refund is included in the total price calculation. However, if the refund is only applied to those customers who were originally subject to the overcharge (i.e., existing customers only) then the refund is excluded. This procedure reduces the month-to-month volatility of utility indexes and ensures that they reflect current prices and price trends more accurately. Also excluded are refunds that are paid directly to consumers in a separate check and are not part of the bill. The utility indexes do include current-period credits that are based on current consumption, such as purchased gas adjustments and fuel adjustments.

Unit-priced food items. When food items that are sold on a unit basis but lack a labeled weight are being priced, two items are weighed to permit calculation of an average weight for the item. This helps reduce the variability in size that occurs among individual, loose items and is not overly burdensome for the data collection process. For example, if the item being priced is Red Delicious apples, and the price is 50 cents each, the BLS field staff reports the price of one apple and the combined weight of two apples taken from the produce rack. In computing the price per ounce, the combined weight is divided by 2, and the 50-cent price of the Red Delicious apple is divided by this average weight.

Container deposits. BLS collects information on container deposits for a variety of nonalcoholic and alcoholic beverages to reflect the influence of changes in deposit legislation on price change. Consumers who purchase throw-away containers are considered to be purchasing both the product itself and the convenience of throwing the container away. When a local jurisdiction enacts deposit legislation and no longer allows stores to sell throwaway containers, those consumers who were previously purchasing throwaway containers may experience a change in the price of this convenience. The price of the same-sized container of product plus its deposit establishes an upper bound for the price change, because the consumer could retain the former convenience by now purchasing returnables and simply throwing them away. In similar fashion, information about deposits and the status of legislation can be used to estimate price change when a container bill is repealed. Changes due to the enactment or repeal of container bills are shown in data for the month in which the legislation becomes effective.

Sales taxes. The CPI includes all applicable taxes paid by consumers for services and products purchased. Many prices for services and products used to calculate the CPI are collected with taxes included because this is the manner in which they are sold. Examples are tires and cigarettes. Other prices are collected excluding applicable taxes, with those taxes subsequently added in the Washington office. The tax rates for these items are determined from secondary sources based on the State, country, and local tax structure governing the sale of the service or product at the point of purchase.

Index calculation. As stated earlier, the CPI is actually calculated in two stages. Earlier sections described the first stage of that calculation—how the CPI calculates the basic or elementary indexes, which show the average price change of the items in each of the 8,018 CPI item–area combinations. 29 The next section describes the second stage of calculation: how the aggregate indexes are produced by averaging across the 8,018 CPI item–area combinations.

Estimation of upper level price change: Aggregation of elementary CPI data into published indexes requires three ingredients: elementary indexes, elementary expenditures to use as aggregation weights, and a price index aggregation formula that uses the expenditures to aggregate the sample of elementary indexes into a published index.

Input elementary price indexes: The CPI-U, CPI-W, and all versions of the C-CPI-U are constructed by using the same combination of Laspeyres and geometric mean elementary indexes. In other words, the prices for each series are combined in the same way to form the elementary price indexes.

Input elementary expenditure weights: To aggregate elementary indexes into published indexes, an aggregation weight for each elementary item–area combination is required. The function of the aggregation weight is to assign each elementary index a relative importance or contribution in the resulting aggregate index. The aggregation weight corresponds to consumer tastes and preferences and resulting expenditure choices among the 211 elementary items in the 38 elementary areas comprising the CPI sample, for a specified period.

CPI-U and CPI-W. In the CPI-U and CPI-W, aggregation weights (AW) are defined as

$$_{i,a,p}AW_{\beta} = \frac{_{I,a,p}(P_{\alpha} Q_{\beta})}{100}$$

Where $_{i,a,p}P_{\alpha}$ is the estimated price of item (i) purchased in area (a) by population (p) in period (α), and $_{I,a,p}Q_{\beta}$ is the estimated quantity of item (i) purchased in area (a) by population (p) in period (β). Period (α) is the base period of the corresponding elementary item-area index. For example, the "sports equipment" (ITEM=RCO2) in Seattle (AREA = A423) index has a base period of α= June 1985. CPI elementary indexes have varying base periods. Most published indexes have an index base period of α= 1982-1984.

The quantity (β) corresponds to the reference period of the expenditures used to derive the implicit quantity weights needed for Laspeyres aggregation. As of 2014, the CPI-U and CPI-W had an expenditure

reference period of β= 2011-2012. Historically, the CPI expenditure reference period was updated approximately every 10 years (See table 2). In 2002, BLS instituted a biennial rotation schedule for updating the expenditure reference period. Effective with the January 2004 index, the expenditure reference period changed from β = 1999 – 2000 to β = 2001 – 2002; effective with the January 2006 index, it was updated again to 2003–2004; and so forth. It is worth noting that a change in the expenditure reference period results in a change in the implicit quantity (Q) assigned to each elementary index.

Table 2 Expenditure reference periods for the Consumer Price Index, All Urban Consumers (CPIU-U) and the Urban Wage Earners and Clerical Workers (CPI-W), 1917 -2015.

Expenditure reference period	Month introduced	Terminal month
1917-1919	1919	Dec. 1924
Avg. 1917-1919 and 1934-1936	Jan. 1925	Dec. 1929
1934-1936	Jan. 1930	Dec. 1949
1947-1949	Jan.1950	Dec. 1952
1950	Jan. 1953	Dec. 1963
1960-1961	Jan. 1964	Dec. 1977
1972-1973	Jan. 1978	Dec. 1986
1982-1984	Jan. 1987	Dec. 1997
1993-1995	Jan. 1998	Dec. 2001
1999-2000	Jan. 2002	Dec. 2003
2001-2002	Jan. 2004	Dec. 2005
2003-2004	Jan. 2006	Dec. 2007
2005-2006	Jan. 2008	Dec. 2009
2007-2008	Jan. 2010	Dec. 2011
2009-2010	Jan. 2012	Dec. 2013
2011-2012	Jan. 2014	Dec. 2015

Note: Prior to January 1953, previously published indexes often were revised retroactively, on the basis of more recent consumer expenditure data.
Source: U.S Bureau of Labor Statistics.

Aggregation weights for the CPI-U and CPI-W are derived from estimates of household expenditures collected in the CE. Despite an increase in the CE sample size in 1999, expenditure estimates at the elementary item–area level would be unreliable due to sampling error without the use of statistical smoothing procedures. BLS uses two basic techniques to minimize the variance associated with each elementary item–area base-period expenditure estimate. First, data are pooled over an extended period in order to build the expenditure estimates on an adequate sample size. The current reference period (β) uses 24 months of data. Second, elementary item–area expenditures are averaged, or composite-estimated, with item-regional expenditures. This has the effect of lowering the variance of each elementary item–area expenditure at the cost of biasing it toward the expenditure patterns observed in the larger geographical area. This process is summarized in the equations in exhibit 3.

2.2.12 Exhibit 3. Estimation of CPI-U elementary aggregation weights

Expenditure on item (i) in area (a) by population (p) in year (β_n) $_{I,a,p}\ (PQ)_{\beta n}$

Total expenditures in area (a) by population (p) in year (β_n) $\Sigma_{i,a,p}\ (PQ)_{\beta n}$

Share of total expenditures for item (i) in area (a) for population (p) $_{I,a,p}\ S_{\beta n} = \frac{_{I,a,p}\ (PQ)_{\beta n}}{\Sigma_{i,a,p}\ (PQ)_{\beta n}}$

in year $(\beta)_n$ $i,a\in m,p$

Share of total expenditures for item (i) in area (m) for population (p) $_{I,m,p}\ S_{\beta n} = \frac{_{I,m,p}(PQ)_{\beta n}}{\Sigma_{i,m,p}\ (PQ)_{\beta n}}$

In year (β_n) $I,m\in m,p$

Composite-estimated share of total expenditures for $_{I,a,p}S_{\beta n} = \delta(_{I,m,p}S_{\beta n}) + (1-\delta)(_{I,a,p}S_{\beta n})$

item (i) in area (a) for population (p) in year (β_n)

Estimated expenditure on item (i) in $_{I,a,p}\ (PQ)_{\beta n} = \{\Sigma_{i,a,p}\ (PQ)_{\beta n}\} \times {}_{I,a,p}S_{\beta n}$

area (a) by population (p) in year (β_n)

Raked expenditure on item (i) in $_{I,a,p}\ (PQ) = {}_{I,a,p}\ (PQ)_{\beta n} \times \frac{\Sigma_{i,a,p}\ (PQ)_{\beta n}}{\Sigma_{i,a,p}\ (PQ)_{\beta n}}$

area (a) by population (p) in year (β_n) $I,a\in e,m$

Estimated expenditure in expenditure reference period (β) $_{I,a,p}\ (PQ)_\beta = 1/N\{\Sigma_{i,a,p}\ (PQ)_{\beta n}\}$

$n=1$

Exhibit 3. Estimation of CPI-U elementary aggregation weights - continued

Cost weight in pivot month (v) $_{I,a,p}\ (P_vQ_\beta) = {}_{I,a,p}\ (PQ)_\beta \times {}_{I,a,p}\ \frac{IX_{a,v}}{IX_{a,\beta}}$

Aggregation weight $_{I,a,p}\ (p_\alpha Q_\beta) = \frac{_{I,a,p}\ (P_vQ_\beta)}{}$

$_{I,a,p}\ IX_{\alpha,v}$

Where

P = population (urban or urban wage-earner)

a = CPI elementary area

i = CPI elementary item

e = expenditure class

m = One of eight CPI major areas, defined by region and city-sized classification. Regions are Northeast, Midwest, South, and West; city-size types are self-representing and non-representing

p = price

Q = quantity

N = number of years in the CPI-U expenditure reference period (NOTE: Currently, N =2.)

B_n = year belonging to expenditure reference period β (NOTE: n=1 is 1999 and n=2 is 2000 in the current CPI-U expenditure reference period.)

δ = weight assigned to major area (m), where $0 < \delta < 1$

– –

α = lower-level index base period

v = year and month, usually December, prior to the month when expenditure weights from reference period β are first used in the CPI

$_{I,a,p}S_{\beta n}$ = estimated expenditures (PQ) for item (i) in area (a) for population (p) as a percent of total CPI expenditures in area (a) in period β_n.

$_{I,a}\ IX_{\alpha,\beta}$ = lower-level index of price change from index base period (α) to expenditure reference period (β) for item (i) in area (a)

$_{I,a}\ IX_{\alpha,V}$ = lower-level index of price change from index base period (α) to pivot-month (v) for item (i) in area (a)

The estimated expenditure $_{I,a,p}(PQ)_{\beta n}$, for item (i) in area (a) for population (p) in reference period (β) is derived from a weighted average of the item's relative importance in the elementary area (a) and its relative importance in its corresponding region-size classification (m), for each year encompassing reference period (β). The weight (δ) assigned to the region-size class (m) and the weight (1 – δ) assigned to the elementary area (a) are a function of the variance in each area and the covariance of each measure. The resulting average share (s) is then multiplied by the sum of all expenditures in the

elementary area in the corresponding year to obtain a revised item expenditure. In a process called "raking," the revised item expenditures are adjusted by a factor such that, once summed, they equal the unadjusted expenditures at the region-size class (m) expenditure class (e) level. Annual item–area expenditures (βn) have a lower bound of 1 cent ($0.01). The raked item expenditures in each year of reference period (β) are then averaged to obtain the estimated expenditure in (β). Finally, the estimated expenditure is adjusted by the corresponding item–area index to obtain the aggregation weight: an expenditure value with an implicit price of period (α) and implicit quantity of period (β).

Because the initial version of the C-CPI-U is published simultaneously with the CPI-U, it uses expenditure data from the same expenditure reference period (β) as the CPI-U as aggregation weights. Unlike those in the CPI-U, however, the expenditures are not adjusted forward to a December pivot month and rebased so that the implicit price corresponds to the item–area index base period. Rather, the estimated expenditure weights with implicit prices of period (β) and implicit quantities of period (β) are used as aggregation weights. Before 2015, the interim version of each monthly C-CPI-U index was published in February of the ensuing year. Hence, if the ensuing year was one in which the weight was updated, then the interim version of each monthly C-CPI-U was based on more contemporaneous expenditures than its initial version. For example, 2012 initial indexes produced in 2012 used β = 2009–2010. Interim indexes for 2012 were produced in 2013 and likewise used β = 2009–2010. Initial indexes for 2013 also used β = 2009–2010. However, 2013 interim indexes produced in 2014 (a weight update year) were constructed using β = 2011–2012.

Final C-CPI-U. For the final C-CPI-U, which uses the Törnqvist index for upper-level aggregation in a monthly chained construct, monthly expenditure estimates for each elementary item–area combination are required as aggregation weights. These are derived from the same CE data as the CPI-U aggregation weights. Like the biennial data used for CPI-U aggregation, adequacy of the underlying sample size from which the expenditure weights are estimated is an issue for C-CPI-U aggregation. To minimize the variance of the elementary item–area monthly expenditures, a ratio-allocation procedure is adopted to estimate each item–area monthly expenditure from U.S. monthly item expenditures:

2.2.13 Estimation of monthly expenditures at the elementary level

Estimated monthly expenditures

$$_{I,a,p}(PQ)_t = {}_{I,a\in I,a}{}^{a}\Sigma\ {}_{i,a,p}(PQ)_t \quad \frac{{}_{t\in T}{}^{T}\Sigma_{i,a,p}(PQ)_t}{{}_{I,a,\in A}{}^{a}\Sigma\ {}_{t\in T}{}^{T}\Sigma_{i,a,p}(PQ)_t}$$

Where

p = population (NOTE: C-CPI-U is produced for the urban population only.)

a = CPI elementary area

i = CPI elementary item

A = all CPI elementary areas ("U.S. city average")

P = price

Q = quantity

t = month

T = period covering month (t) and 11 months prior to month (t)

The monthly expenditure for an item in an elementary area is derived in two steps: First, the monthly expenditure for the item is summed across all areas to obtain a U.S. monthly item expenditure. Second, the U.S. monthly item expenditure is allocated among all 38 elementary areas, according to each area's relative expenditure share for the item during the current and preceding 11 months. Note that

$_{I,A}(PQ)_t = {}_{I,A}(P^{\wedge} Q^{\wedge})_t$.

The estimated monthly item–area expenditures have a lower bound of 1/12th of a penny ($0.000833), and when summed over the calendar year, they have a lower bound ($.01) equivalent to that of the annual data in the CPI-U expenditure reference period.

Aggregation formula: A Laspeyres price index is used to aggregate elementary indexes into published CPI-U and CPI-W indexes. The Laspeyres index uses estimated quantities from the predetermined expenditure reference period (β) to weight each elementary item–area index. These quantity weights remain fixed for a 2-year period, and then are replaced in January of each even year when the aggregation weights are updated. In a Laspeyres aggregation, consumer substitution between items is assumed to be zero. The aggregate index for any given month is computed as a quantity-weighted average of the current month index divided by the index value in the index base period. Month-to-month price change is then calculated as a ratio of the long-term monthly indexes. The relevant equations are as follows:

CPI-U and CPI-W upper-level aggregation formula

Long-term price change

$$_{I,A,P}IX^{L}_{\{Z,T\}} = {}_{I,A,P}IX^{L}_{\{z,v\}} \times \frac{{}_{I,a\in I,A}\Sigma_{i,a,p}\, AW_{\beta}\, X_{I,a,p}\, IX^{LorG}_{\{\alpha;t\}}}{{}_{I,a\in I,A}\Sigma_{i,a,p}\, AW_{\beta}\, X_{I,a,p}\, IX^{LorG}_{\{\alpha;v\}}}$$

Month – to - month price change

$$_{I,A,P}IX^{L}_{\{t-1;t\}} = \frac{{}_{I,A,P}IX^{L}_{\{z;t\}}}{{}_{I,A,P}IX^{L}_{\{Z;T-1\}}},$$

Where

A = all elementary areas (“U.S. city average”)

a = CPI elementary area

p = population (the C-CPI-U is calculated for the U-population only.)

i = CPI elementary item

I = all elementary items (“all-items”)

t = month

z = base period of the aggregate index (Note: the U.S. city average, all-items CPIU index has a base period of z = 1982–1984.)

α = base period of the elementary index (i) in area (a)

v = year and month, usually December, prior to the month when expenditure weights from reference period (β) are first used in the CPI

$_{I,a}IX_{\{\alpha;t\}}$ = lower-level index of price change from period (α) to month (t) for item (i) in area (a)

$_{A,P}IX^{L}_{\{\alpha,v\}}$ = lower-level index of price change from period (α) to pivot-month (v) for item (i) in area (a)

$_{I,A,P}IX^{L}_{\{z,v\}}$ = aggregation weight from reference period (β) for item (i) in area (a)

$_{I,A,P}IX^{L}_{\{z,v\}}$ = aggregate-level CPI-U index of price change from period (z) to pivot month (v) for aggregate item (I) in aggregate area (A) for population (p)

In contrast, the C-CPI-U is built by chaining together indexes of 1-month price change. For the final CCPI-U index, each monthly index is computed using the Törnqvist formula with monthly weights from both the current and previous month. Consumer substitution behavior is not assumed by the Törnqvist formula; rather, it is implicitly accounted for by use of current- and base-month expenditures. An index of 1-month price change is calculated and then multiplied by the index value for the previous month to obtain the current month index value. Following are the relevant equations:

Final C-CPI-U upper-level aggregation formula

Long-term price change

$$_{I,A,P}PIX^{T}_{\{z;t\}} = {}_{I,A,P}IX^{T}_{\{z;t-1\}} \times {}_{I,A,P}IX^{T}_{\{t-1;t\}} ,$$

Month-to-month price change

$$_{I,A,P}IX^{T}_{\{t-1;t\}} = \prod_{I,a\in I,A} \left\{ \frac{_{I,a,p}IX_{\{\alpha;t\}}}{_{I,a,p}IX_{\{\alpha;t-1\}}} \right\}^{LorG}{}_{I,a,p}S_{t-1} + {}_{I,a,p}S_{t}$$

where

p = population (Note: the C-CPI-U is calculated for the urban consumer population only.)

a = CPI elementary area

A = aggregate area

i = CPI elementary item

I = aggregate item

z = base period of the aggregate index (NOTE: the U.S. city average, all-items C-CPI-U in dex has a base-period of z = December 1999.)

a = base period of the elementary index (i) in area (a)

t = month

$_{I,a}IX_{\{\alpha;t\}}$ = lower-level index of price change from period (α) to month (t) for item (i) in area (a)

$_{I,a}IX_{\{\alpha;t-1\}}$ = lower-level index of price change from period (α) to month (t – 1) for item (i) in area (a)

$_{I,a}S_t$ = expenditure in month (t) for item (i) in area (a) as percentage of total expenditures in month (t) for aggregate item (I) in aggre gate area (A)

$_{I,a}S_{t-1}$ = expenditure in month (t-1) for item (i) in area (a) as percent of total expenditures in month (t – 1) for aggregate item (I) in aggregate area (A)

$_{I,A}IX^{T}_{\{z;t\}}$ = aggregate-level C-CPI-U Törnqvist index of price change from period (z) to month (t) for aggregate item (I) in aggregate area (A)

Starting in 2015, BLS began revising the Chained Consumer Price Index for All Urban Consumers (C-CPI-U) quarterly, and the Constant Elasticity of Substitution (CES) formula will replace the adjusted geometric mean formula for the calculation of the preliminary versions of that index.

The initial version of the C-CPI-U will continue to be released concurrently with the CPI-U for each calendar month. The C.E.S. formula will be used to calculate the C-CPI-U. The final version of the index will be released approximately 10–12 months later, according to the publication schedule outlined in the following table: C-CPI-U quarterly release schedule.

C-CPI-U quarterly release schedule.

Index month	Quarterly release				
	1(Feb)	**2(May)**	**3(Aug)**	**4(Nov)**	**5(Feb)**
y-1,1	**Final**	Final	Final	Final	Final
y-1,2	**Final**	Final	Final	Final	Final
y-1,3	**Final**	Final	Final	Final	Final
y-1,4	$Interim_3$	**Final**	Final	Final	Final
y-1,5	$Interim_3$	**Final**	Final	Final	Final
y-1,6	$Interim_3$	**Final**	Final	Final	Final
y-1,7	$Interim_2$	$Interim_3$	**Final**	Final	Final
y-1,8	$Interim_2$	$Interim_3$	**Final**	Final	Final
y-1,9	$Interim_2$	$Interim_3$	**Final**	Final	Final
y-1,10	$Interim_1$	$Interim_2$	$Interim_3$	**Final**	Final
y-1,11	$Interim_1$	$Interim_2$	$Interim_3$	**Final**	Final
y-1,12	$Interim_1$	$Interim_2$	$Interim_3$	**Final**	Final
y,1	Initial	$Interim_1$	$Interim_2$	$Interim_3$	**Final**
y,2		$Interim_1$	$Interim_2$	$Interim_3$	**Final**
y,3		$Interim_1$	$Interim_2$	$Interim_3$	**Final**
y,4		Initial	$Interim_1$	$Interim_2$	$Interim_3$
y,5			$Interim_1$	$Interim_2$	$Interim_3$
y,6			$Interim_1$	$Interim_2$	$Interim_3$
y,7			Initial	$Interim_1$	$Interim_2$
y,8				$Interim_1$	$Interim_2$
y,9				$Interim_1$	$Interim_2$
y,10				Initial	$Interim_1$
y,11					$Interim_1$
y,12					$Interim_1$
y+1,1					Interim

In the table, the lightface italic gray text indicates that the final index has been released earlier. Thus, reading down the first column shows that, in February of the current year (y, 2), the final version will be released for the first 3 months (January, February, and March) of the previous year (y – 1, 1; y – 1, 2; and y – 1, 3) and the initial version will be released for January of the current year (y, 1). Column 5 of the current year corresponds to column 1 of the previous year. The other columns are read similarly. A blank cell indicates that it is too early to have an index for that month at that time.

The final index will continue to be calculated with the Törnqvist formula. In between the initial release and the final release, there will be three quarterly updates, noted as Interim (1), Interim (2), and Interim (3) in the table. The 1-month price change for each interim release will be the same as the initial version. The interim versions reflect only updates to index levels—that is, the value of the index in a given month relative to the value in its base period. These updates result from the conversion of 1-month price changes from initial to final value in preceding months in the monthly chained series.

The CES uses an estimate of consumer substitution that lies between the estimates assumed in the geometric mean and Laspeyres formulas, and represents a model that is closer to actual consumer behavior. This estimate of consumer substitution, sigma (σ), is called the elasticity of substitution.

$$ {}_{I,A}IX^{C}_{\{t-1;t\}} = \left(\Sigma_{i,a\in I,A}\left(\left(\frac{E^{c}_{i,a,v,bx,\delta}}{\Sigma_{i,a\in I,A}\,E^{c}_{i,a,v,bx,\delta}}\right)\left(\frac{IX_{i,a,t}}{IX_{i,a,\{v\}}}\right)^{(1-\delta)}\right)\right)^{(1/1-\delta)} $$

$$ \left(\Sigma_{i,a\in I,A}\left(\left(\frac{E^{c}_{i,a,v,bx,\delta}}{\Sigma_{i,a\in I,A}\,E^{c}_{i,a,v,bx,\delta}}\right)\left(\frac{IX_{i,a,t-1}}{IX_{i,a,\{v\}}}\right)^{(1-\delta)}\right)\right)^{1/1-\delta} $$

New formulas and quarterly release schedule

The CES month-to-month index relative for a biennial period is:

$$ E^{c}_{i,a,v,bx,\delta} = P_{b}^{i,a}\,Q_{b}^{i,a}\left(\frac{IX_{i,a,\{v\}}}{IX_{i,a,\{bx\}}}\right)^{(1-\delta)} $$

where

C = C.E.S index/weight,

i = elementary item stratum,

I = aggregate item, a = elementary index area,

A = aggregate index area,

IX = component index,

T = current calendar month in calendar year y (e.g., if $IX_{yymm} = IX_{0308}$, then t = August and y = 2003),

t –1 = calendar month previous to calendar month t,

x = reference period of index (initially, x = December 1999),

$P_{b}^{i,a}$ = biennial expenditure reference period,

$Q_{b}^{i,a}$ = during biennial expenditure reference period

σ = sigma for component and aggregate index periods and for weight period, and

V = pivot month index period.

2.2.14 Calculation of seasonally adjusted indexes

Seasonal adjustment. Seasonal adjustment removes the estimated effect of changes that normally occur at the same time every year (such as price movements resulting from changing climatic conditions, production cycles, model changeovers, holidays, and sales). CPI series are selected for seasonal adjustment, if they pass certain statistical criteria and if there is an economic rationale for the observed seasonality. Seasonal factors used in computing the seasonally adjusted indexes are derived, using X-13ARIMA-SEATS seasonal adjustment software. X-13ARIMA-SEATS is an extension of the X-12 variant of the Census Method II Seasonal Adjustment methodology. In some cases, intervention analysis seasonal adjustment is carried out using X-13ARIMA-SEATS, to derive more accurate seasonal factors. Consumer price indexes may be adjusted directly or aggregately, depending on the level of aggregation of the index and the behavior of the component series.

Intervention analysis seasonal adjustment. Some index series show erratic behavior due to non-seasonal economic events (called interventions) or methodology changes. These events, which can be one-time occurrences or recurring events that happen at infrequent and irregular intervals, adversely affect the estimate of the seasonal component of the series.

Intervention analysis seasonal adjustment allows non-seasonal economic phenomena, such as outliers and level shifts, to be factored out of indexes before calculation of seasonal adjustment factors. (An outlier is an extreme value for a particular month. A level shift is a change or shift in the price level of a CPI series caused by an event, such as an excise tax increase or oil embargo, occurring over one or more months.) An index series whose underlying trend has experienced a sharp and permanent shift will generate distorted results when adjusted using the standard X-13ARIMA-SEATS procedure. X-13ARIMA-SEATS regression techniques are used to model the distortions and account for them as part of the seasonal adjustment process. The result is an adjustment based on a representation of the series with the seasonal pattern emphasized. Intervention analysis seasonal adjustment also makes it possible to account for seasonal shifts, resulting in a better seasonal adjustment in the periods before and after the shift occurred. Not all CPI series are adjusted using intervention analysis seasonal adjustment techniques. However, for affected series, the resulting seasonal factors better represent the true seasonal pattern than factors calculated without these techniques. These seasonal factors are applied to the original unadjusted series. Level shifts and outliers, removed in calculating the seasonal factors, remain in the resulting seasonally adjusted series.

In recent years, BLS has used intervention analysis seasonal adjustment for various indexes—gasoline, fuel oil, new vehicles, women's and girls' apparel, educational books and supplies, electricity, utility (piped) gas service, water and sewerage maintenance, nonalcoholic beverages and beverage materials, and whiskey at home are examples. Series are adjusted using intervention analysis techniques when interventions are clearly identified. After a number of years, series may revert to adjustment using standard methods. In addition, for some series, intervention analysis is used, and the resulting series does not show a clear and stable seasonal pattern. In these cases, the series is not seasonally adjusted.

Direct and aggregative adjustment. Each year, BLS seasonally adjusts eligible lower level CPI index series directly with the X-13ARIMA-SEATS software using unadjusted indexes for the latest 5 to 8 calendar years. CPI index series are adjusted using the multiplicative model. Most high-level index series are adjusted by the aggregative method, which is more appropriate for broad categories whose component indexes show strongly different seasonal patterns. Under the aggregative method, direct adjustment is first applied to indexes at lower levels of detail, and thereafter the adjusted detail is aggregated to yield the higher level seasonally adjusted indexes. If intervention analysis is indicated, it will be used in adjusting selected lower level indexes prior to aggregation. For those series that have not been selected for seasonal adjustment, the original, unadjusted data are used in the aggregation process.

Revision. The seasonal factors are updated annually. Each year in February, BLS recalculates and publishes revised seasonally adjusted indexes for the previous 5 years. Seasonally adjusted indexes become final in the last and 5th year of revision. Seasonal factors for the past year are used to generate seasonally adjusted indexes for the current year starting with the release of the January CPI.

2.2.15 Calculation of annual and semiannual average indexes

CPI annual average indexes use 12 successive months of CPI values as

$$I_{12av} = {}^{12}_{t=1}\Sigma\, I_{t,0}/12$$

Semiannual average indexes are computed for the first half of the year (January to June) and for the second half of the year (July to December) using six successive months of CPI values as

$$I_{6av} = {}^{6}_{t=1}\Sigma I_{t,0}/6$$

Where the value of each monthly index is real or interpolated, depending on availability.

For bimonthly indexes, the intermediate indexes are calculated using a geometric mean of the values in the months adjacent to the one being estimated.

Average Prices: Average prices are estimated from CPI data for selected food and beverage items, utility (piped) gas, electricity, gasoline, automotive diesel fuel, and fuel oil to support the research and analytic needs of CPI data users. Average food prices are published without tax, while the other average prices are published with tax included. For each food and beverage item, the average price for a specified unit of size (for instance, pound or gallon) is published monthly for the U.S. city average and for the four regions: Northeast, Midwest, South, and West. Metric-equivalent sizes are shown, as well.

Average prices for utility (piped) gas, electricity, and gasoline are published monthly for the U.S. city average, the four regions, the three population size classes, 10 region/size-class cross-classifications, and the 14 largest local index areas. For utility (piped) gas, average prices per therm are published. For electricity, average prices per kilowatt-hour (kWh) are published. For gasoline, the average price per gallon is published. Average prices for commonly available grades of gasoline are published, as well as the average price across all grades. Average prices per gallon for automotive diesel fuel and fuel oil #2

are published monthly for the U.S. city average, the four regions, the three population size classes, and 10 of 12 region/size-class cross-classifications. All eligible prices are converted to a price per normalized quantity. These prices are then used to estimate a price for a defined fixed quantity. For example, prices for a variety of package sizes for flour are converted to prices per ounce. An average price per ounce of flour is then estimated and multiplied by 16 to yield a price per pound, the published quantity.

The average price for collection period t is estimated as

$$P_t = \frac{\Sigma_i W_{it} P_{it} / P_{ib}}{\Sigma_i W_{it} / P_{ib}},$$

where Wit is the quote-level expenditure weight of items used in the average price estimation for the ELI/PSU/replicate.

Dividing the expenditure weight by the base price, P_{ib}, for a given quote yields an implicit estimate of quantity. Thus, the average price is, conceptually, a weighted average of prices, Pit, where the weights are quantity amounts. Imputed prices are used in estimating average prices.

Precision of CPI estimates: An important advantage of probability sampling methods is that a measure of the sampling error of survey estimates can be computed directly from the sample data. The CPI sample design accommodates error estimation by making two or more selections (replications) of items and outlets within an index area. Therefore, two or more samples of quotes in each self-representing PSU and one in each non-self-representing PSU are available. With this structure, which reflects all stages of the sample design, variance estimation techniques using replicated samples can be used.

Sources of error: We divide the total error into two sources: sampling error and non-sampling error. Sampling error is the uncertainty in the CPI caused by the fact that a sample of retail prices is used to compute the CPI, instead of using the complete universe of retail prices. The sampling variance attributable to the estimation of expenditure weights (see chapter 16 for more detail on consumer expenditure weights) is directly incorporated in the variance estimates computed for the CPI, due to the fact that these expenditures are independently estimated for each replicate. Non-sampling error is the rest of the error, and will be discussed at the end of this section. Incorrect information given by survey respondents and data processing errors are examples of non-sampling error.

BLS constantly tries to reduce error in the CPI. Variance and sampling error are reduced by using samples of retail prices and samples of consumer expenditures that are as large as possible, given resource constraints. The Bureau has developed a model that optimizes, on a 2-year basis, the allocation of resources. The model indicates the number of prices that should be observed in each geographic area and each item category to minimize the variance of the U.S. city average all-items index. The Bureau reduces non-sampling error through a series of computerized and professional data reviews, as well as through continuous survey process improvements and theoretical research.

Sample design: Starting in 1978 the CPI's sample design has accommodated variance estimation by using two or more independent samples of items and outlets in each geographic area. This allows two or

more statistically independent estimates of the index to be made. The independent samples are called replicates, and the set of all observed prices is called the full sample. As discussed earlier, BLS calculates CPI indexes for 38 geographic areas across the United States. The 38 areas consist of 31 self-representing areas and 7 non-self-representing areas. Self-representing areas are large metropolitan areas, such as the Boston metropolitan area, the St. Louis metropolitan area, and the San Francisco metropolitan area. Non-self-representing areas are collections of smaller metropolitan areas. For example, one non-self-representing area is a collection of 32 small metropolitan areas in the Northeast region (Buffalo, Hartford, Syracuse, Burlington, and others) of which 8 have been randomly selected to represent the entire set. Within each of the 38 areas, price data are collected for 211 item categories called item strata. Together, the 211 item strata cover all consumer purchases.

Multiplying the number of areas by the number of item strata gives 8,018 (= 38 × 211) different area-item combinations for which price indexes need to be calculated. Separate price indexes are calculated for each one of these 8,018 area item combinations. After calculating all 8,018 of these basic level indexes, the indexes are then aggregated to form higher level indexes, using expenditure estimates from the CE as their weights. CPI variances are primarily computed with a stratified random groups method, for 1-, 2-, 6- and 12-month percent changes. From 1978 to 1998, the BLS computed CPI variances by using a first-order Taylor approximation of the ratio of cost weights. This methodology was replaced, beginning in January 1998, by the stratified random groups method, in which variances are computed separately for certain subsets of areas and items, and then those individual variances are combined to produce the variance of the entire item–area combination. Subsets of items are formed by the intersection of the item category with each 1 of the 8 major groups.

Variance estimation using replicates: Let IX (A, I, f, t) denote the index value for area = A, item category = I, in month = t, where f indicates that it is the full sample value, and let IX(A, I, f, t – k) denote the value of the same index in month = t – k. The uppercase letter A denotes a set of areas, such as the Northeast or Midwest region of the country, and the uppercase letter I denotes a set of item strata, such as all items or all items less food and energy, or even a single item stratum. Also, let IX (A, I, r, t) and IX (A, I, r, t – k) be the corresponding index values for replicate = r. Most areas have two replicates, but some have more. Then the full-sample kmonth percent change between months t – k and t is computed by dividing IX (A, I, f, t) by IX (A, I, f, t – k), subtracting 1, and multiplying by 100:

$$PC (A, I, f, t, t\text{-}k) = \{ \frac{IX (A, I, f, t)}{IX (A, I, f, t\text{-}k)} - 1 \} \times 100$$

Every index has an aggregation weight AGGWT (A I, f) or AGGWT (A, I, r) associated with it, which is used to combine the index with other indexes to produce indexes for larger geographic areas and larger item categories. For example, the aggregation weights are used to combine all 8,018 basic-level indexes into higher level indexes such as the U.S. city average-all-items index. The product of an index and its weight is called a cost weight:

CW (A, I, f, t) = IX (A, I, f, t) × AGGWT (A, I, f, t).

A cost weight is an estimate of the total cost in area = A for consumption of item category I in month t. A replicate cost weight would be indexed with r instead of f. Because the aggregation weights are not indexed by time (except across pivot months; see section titled “Bridging across pivot months”), the preceding percent change formula is equivalent to

$$PC (A, I, f, t, t-k) = \{ \frac{CW (A, I, f, t)}{CW (A, I, f, t-k)} - 1 \} \times 100$$

Which is equivalent to

$$PC (A, I, f, t, t-k) = \{ \frac{a€\Sigma_{Ai€1} \Sigma CW (a, I, f, t)}{a€\Sigma_{Ai€1} \Sigma CW (a, I, f, t-k)} - 1 \} \times 100$$

because cost weights are addictive from the lowest area-item level up to the highest U.S. city average-all-items level. The lowercase letter a denotes one of the 38 basic-level areas included in area = A, and the lowercase letter I denotes one of the 211 items categories. (Note: Item aggregation I can be as small as one item stratum or may comprise one or more major groups.)

For the stratified random groups method, a replicate percent change is defined as follows: At each item-area replicate level, the individual full sample cost weight, CW (a, I, f, t*), is added back in. The replicate percent change for area=a, item subset =I, replicate=r between months t-k and t is then computed as follows:

$$PC_s (a, I, r, t, t-k) = \{ \frac{CW (A, I, f, t) – CW (a, I, f, t) + CW (a, I, r, t)}{CW (A, I, f, t-k) – CW (a, I, f, t-k) + CW (a, I, r, t-k)} - 1 \} \times 100$$

For self-representing areas. For non self-representing areas, another replicate percent change for area=a, item category = 1, replicate = r between months t-k and t is computed as

$$PC_N (a, I, r, t, t-k) = \{ \frac{CW (A, I, f, t) – CW (a, I, f, t) + CW (a, I, r, t)}{CW (A, I, f, t-k) – CW (a, I, f, t-k) + CW (a, I, r, t-k)} - 1 \} \times 100$$

Where

$$CW (A, I, f^*, t^*) = {}_{a€A}\Sigma_{i€1} \Sigma\, CW (a, I, f^*, t^*).$$

The symbol α€A means that the sum is over all basic level areas within area A, and

the symbol i€1 means that the sum is over major groups within item category I.

The variance is computed with the following stratified random groups variance estimation formula:

Table 3. Response rates for commodities and services for the Consumer Price Index, All Urban Consumers (CPI-U), U.S. city average, by major group, 2014

Commodities and services	Eligible	Collected	Percent collected	Used in estimation	Percent in estimation
Outlets	305,184	284,730	93.3	271,931	89.1
Total quotes	1,180,932	970,546	82.2	944,414	80.0
Food and beverages	465,398	418,060	89.8	410,615	88.2
Housing (less shelter)	146,466	125,300	85.5	121,502	83.0
Apparel	135,950	75,102	55.2	70,700	52.0
Transportation	149,721	134,956	90.1	131,796	88.0
Medical care	76,631	40,847	53.3	39,534	51.6
Recreation	84,227	68,427	81.2	65,064	77.2
Education and communication	78,164	68,872	88.1	67,039	85.8
Other goods and services	44,375	38,982	87.8	38,164	86.0

Source: U.S. Bureau of Labor Statistics.

$$V\{PC(A,I,f,t,t\text{-}k)\} = \sum_{i \in C} \sum_{a \in A \cap S} \frac{1}{R_a(R_a-1)} \sum_{r=1}^{R_a} \{PC_s(a,I,r,t,t\text{-}k) - PC(A,I,f,t,t\text{-}k)\}^2$$

$$+ \sum_{a \in A \cap N} \frac{1}{R_a(R_a-1)} \sum_{r=1}^{R_a} \{PC_S(a,I,r,t,t\text{-}k) - PC(A,I,f,t,t\text{-}k)\}^2$$

Where S and N are the sets of all self-representing and non-selfrepresenting areas in the CPI's geographic sample, respectively; and A Π S and A Π N are the sets of all self-representing and non-self-representing areas within area = A. The number R_a is the number of replicates in area = a.

When the item category I no longer spans more than one major group, the preceding formula reduces to

$$V\{PC(A,I,f,t,t\text{-}k)\} = \sum_{a \in A} \frac{1}{R_a(R_a-1)} \sum_{r=1}^{Ra} \{PC(a,I,r,t,t\text{-}k) - PC(A,I,f,t,t\text{-}k)\}^2$$

Variance estimation without replicates BLS computes index series for 85 special (SRC) item categories, which are below the item stratum level and thus do not have accompanying replicate index values. (CE weights are produced only down to the item-stratum level in each index area.) The stratified random groups methodology requires a replicate structure. So, for these SRC items (such as butter or pork or new cars), an alternative variance estimation method is needed. Given the availability (at the regional and higher area levels) of independent estimates for these SRC items, the jackknife variance estimation methodology can be employed. Each area full sample cost weight can be subtracted from the all-area

full sample cost weight to provide a jack-knife replicate estimate. By taking the ratio of these replicate cost weight estimates at times t and t – k, subtracting 1, and multiplying by 100, one obtains the required jackknife replicate percent change value. (For the U.S. city average special item estimates, there are 38 independent index areas, and so 38 jackknife replicate estimates to work with.) The full-sample percent change is computed as before (except that item category = I here is smaller even than an item stratum):

$$PC (A, I, f, t, t\text{-}k) = \frac{CW (A, I, f, t)}{CW (A, I, f, t\text{-}k)} - 1 \} \times 100$$

The jack-knife replicate percent change is computed as follows:

$$PC (A\text{-}a, I, r, t, t\text{-}k) = \{ \frac{CW (A, I, f, t) – CW (a, I, f, t)}{CW (A, I, f, t\text{-}k) – CW (a, I, f, t\text{-}k)} - 1 \} \times 100$$

Then the variance for the k-month percent change is computed in the usual jackknife form

$$V \{ PC (A, I, f, t, t\text{-}k) \} = \frac{N_A – 1}{N_A} \sum_{a \in A} \{ PC (A\text{-}a, I, r, t, t\text{-}k) – PC (A, I, f, t, t\text{-}k) \}^2$$

Bridging across pivot months: Every 2 years, BLS updates its set of aggregation index weights based on CE data collected from the t – 2 and t – 3 years. In January 2012, BLS replaced its old set of aggregation weights with a new 2-year set of weights from expenditure data collected in 2009–2010. In January 2014, this set of weights was replaced by an updated set of weights from expenditure data collected in 2011–2012, and so on. Whenever the variance estimates cross the pivot month (as they did in December 2011 and December 2013), a bridging factor has to be introduced into any variance calculation that crosses the pivot month anywhere between t and t – k months (including month t – k, but not including month t). The bridging factor is then applied directly to the individual ratio of cost weights, for both full-sample and replicate values, inside each percent change calculation. Thus, in its most general form,

$$PC (a^*, i^*, f^*, t, t\text{-}k) = \{ \frac{CW (a^*, i^*, f^*, t)}{CW (a^*, i^*, f^*, t\text{-}k)} \times \frac{CW (a^*, i^*, f^*, t^*old)}{CW (a^*, i^*, f^*, t\text{-}k \text{ new})} - 1 \}$$

for every combination of area and item, and for full-sample and replicate values, with the bridging factor defaulting to 1 whenever not applicable.

The bridging factor, CW (a•, i•, f•, t^* old) / CW (a•, i•, f•, t-k new), essentially allows the old aggregation weight in the bridge's numerator to cancel out the old aggregation weight in the t – k cost weight, while the new aggregation weight in the bridge's denominator cancels out the new aggregation weight in the t cost weight, leaving IX (a•, i•, f•, t) / X (a•, i•, f•, t – k) free to move this level's percent change without disruption. Note that IX (a•, i•, f•, old) / IX (a•, i•, f•, new) = 1 at all times.

Non-sampling error: CPI estimates are subject to non-sampling error as well as sampling error. Surveys involve many operations, all of which are potential sources of non-sampling error. The errors arise from the survey process, regardless of whether the data are collected from the entire universe or from a sample of the population. The most general categories of non-sampling error are coverage error, nonresponse error, response error, processing error, and estimation error.

Coverage error in an estimate results from the omission of part of the target population (under coverage) or the inclusion of units from outside of the target population (over coverage). Coverage errors result from the omission of cities, households, outlets, and items that are part of the target populations from the relevant sampling frames or from their double-counting or improper inclusion in the frames. A potential source of coverage error is the time lag between the TPOPS and the initiation of price collection for commodities and services at sampled outlets. Because of the time lag, the products offered by the outlet at the time pricing is initiated may not coincide with the set from which the TPOPS respondents were purchasing.

Nonresponse error results when data are not collected for some sampled units because of the failure to interview households or outlets. This can occur when selected households and outlets cannot be contacted or refuse to participate in the survey. Nonresponse rates during monthly pricing for the CPI C&S and housing surveys are shown in tables 3 (page 38) and 4 (page 40).

Table 4. Response rates for shelter for the Consumer Price Index, All Urban Consumers (CPI-U), U.S. city average, 2014.

Shelter	Eligible	Collected data reported	No data collection or other
Number of total units	99,383	72,966	26,417
Percentage of eligible units	100	73.4	26.6

Source: U.S. Bureau of Labor Statistics.

Response error results from the collection and use in estimation of incorrect, inconsistent, or incomplete data. Response error may arise because of the collection of data from inappropriate respondents, respondent memory or recall errors, deliberate distortion of responses, interviewer effects, misrecording of responses, pricing of wrong items, misunderstanding or misapplication of data collection procedures, or misunderstanding of the survey needs and/or lack of cooperation from respondents. The pricing methodology in the commodities and services component of the CPI allows the previous period's price to be available at the time of collection. This dependent pricing methodology is believed to reduce response variance for measuring change, but may cause response bias and lag. The housing component of the CPI employs an independent pricing methodology specifically to avoid potential response bias.

Processing error arises from incorrect editing, coding, and data transfer. Price data are collected by CADC. Automated data checking ensures that only correct data types are collected; other automated logic checks remove all redundant question patterns, and the instrument informs the field staff when

not all required data have been collected. In both systems, errors also can result from software problems in the computer processing that cause correctly entered data to be lost. Computer screening and professional review of the data provide checks on processing accuracy. Occasional studies of these processing errors in the CPI have shown them to be extremely small. Estimation error results when the survey process does not accurately measure what is intended. Such errors may be conceptual or procedural in nature, arising from a misunderstanding of the underlying survey measurement concepts or a misapplication of rules and procedures.

Substitutions and adjustments for quality change in the items priced for the CPI are possible sources of estimation error due to procedural difficulties. Ideally, CPI data collection forms and procedures would yield all information necessary to determine or explain price and quality differences for all items defined within an ELI. Because such perfect information is not available, BLS economists supplement directly collected data with secondary data. Estimation error will result, if the BLS adjustment process—which may require significant judgment or lack key data—is misapplied, or if it consistently overestimates or underestimates quality change for particular kinds of items.

The effect of the aging of housing units is an example of potential estimation error, which is similar to the issue of quality change in commodities and services. Until 1988, BLS did not adjust for the slow depreciation of houses and apartments over time. BLS research indicates that annual changes for the residential rent and owners' equivalent rent indexes would have been 0.1 to 0.2 percent larger if some type of aging adjustment had been included.

The total non-sampling error of the CPI results from errors in the type of data collected, the methods of collection, the data processing routines, and the estimation processes. The cumulative non-sampling error can be much greater than the sampling error.

Response rates: Response rates are calculated for the CPI at the data collection phase and at the index estimation phase for ongoing pricing. The response rate at the data collection phase is the number of responding sample units divided by the sum of (1) the number of eligible sample units and (2) the number of sample units with eligibility not determined. A sample unit is eligible if it belongs to the defined target population and responses should be collected from the unit for one or more items. The response rate at estimation is defined as the number of sample units used in estimation divided by the sum of (1) the number of eligible sample units and (2) the number of sample units with eligibility not determined.

Commodities and services items (any except rent and owner's equivalent rent) are further broken down into outlets and quotes. An "outlet" is a generic term used to describe places where prices are collected. A "quote" is a specific item to be priced in a specific outlet. There may be from 1 to more than 50 quotes priced in an outlet. Table 3 shows the relatively low percentages of quotes reported collected and used in estimation for apparel. Low rates for these items largely can be attributed to the design of the apparel sample. Because apparel items are commonly in stores only at certain times of the year, most of the apparel sample is doubled, with each half of the sample designated for pricing during part of the year. Thus, at any particular time of the year many apparel quotes, although eligible, are designated "out of

season," and prices are not collected. For additional information, see the earlier section on seasonal items.

The response rates for housing (shelter) shown in table 4 include categories for renters only. Owners are out of scope for the CPI housing sample. A unit qualifies as renter if its tenure status is known either by previous knowledge or is collected in the current interview period. The response rates at the data collection phase for housing (shelter) are separated into three categories. If usable information is obtained, the unit is designated eligible and data reported. If the assigned unit is located but is unoccupied, the unit is designated "eligible, found vacant." In instances where the unit is eligible but no data are available (for example refusals), the unit is designated "eligible, other." The response rates at the estimation phase are units that are used in either rent or REQ.

2.3 Measuring prices and their rate of change.

{Boskin, M (2022)Government Policy, Macroeconomics, The Marketplace - Consumer Price Indexes}: Measuring prices and their rate of change accurately is central to almost every economic issue, from the conduct of MONETARY POLICY to measuring economic progress (see ECONOMIC GROWTH) over time and across countries to the cost and structure of indexed government spending programs and taxes. Most of us are familiar with the prices of many things we purchase. We know what we paid recently for a proud of ground beef or a quart of milk. Measuring prices, therefore, may seem simple and straight forward, but it is not.

The purchase of a price index is to summarize information on the prices of multiple goods and services over time. Consumer spending accounts for about two thirds of the U.S gross domestic product (GDP). The Consumer Price Index (CPI) and the Personal Consumption Expenditure deflator (PCE) are designed to summarize information on the prices of goods purchased by consumers over time. In a hypothetical primitive society with only one good – say, one type of food – we would not need a price index; we would just follow the price of the one good. When there are many goods and services, however, we need a method for averaging the price changes or aggregating the information on the many different prices. The rate of change of prices – INFLATION – is important in both macro- and MICROECONOMICS. Estimating inflation and real growth, for example, requires measures of price changes, and in a flexible, dynamic modern market economy, obtaining accurate measures is complicated. A single large superstore may contain more than fifty thousand separately priced items. Within that individual store, new items are continually introduced and old items discontinued. The quality of many items improves in some objective way – greater ENERGY efficiency, more durability, less maintenance, to name a few. Of course, many more items claim to have improved. When quality increases but the price stays the same, the real price has fallen. Even with modern scanner technology, summarizing what happened to prices in just one store over a period as short as one month is complicated. Doing so for the entire economy is vastly more complex.

To obtain information on various prices requires not only measuring the prices but also weighting the various components in the index. Weighting each price change equally would be simple but not very revealing. For example, if the price of red delicious apples fell by 5 percent and rent rose by 5 percent,

such an index would suggest that there had been no change in the overall price level. But that would be silly. We need to "weight" the goods on which consumers spend more of their income more heavily than those on which they spend less. The U.S CPI and the Cost of Living: When economists try to measure the "true" inflation rate – the rate of change of prices – it is to answer the question, "How much more income would consumers need to be just as well off with a new set of prices as the old?" Thus, a cost-of-living concept is at the core of proper measures of prices and of changes in prices. This clearly involves tracking "substitution" – that is, how consumers respond to the changes in the relative prices of various goods. It also requires measuring quality-adjusted prices. One would not want to count as inflation a major improvement in quality that resulted in a tiny price increase.

Most traditional consumer price indexes, including the CPI in the United States, measure prices with a fixed weight system, taking the expenditure weights from some base period as given. Table 1 reports the most recent weights on very broad categories of goods from 2002; the Bureau of Labor Statistics (BLS) derives these weights from expenditure surveys that report how much consumers spent on different types of goods and services. For example, at a very broad level of aggregation, those weights are 15.6 percent for food, 6.0 percent for medical care, 40.9 percent for HOUSING, 17.3 percent for transportation, and so on. Within each category, of course, are thousands of specific goods; for example, red delicious apples of a certain size and quality are a component of the apples subcategory, which is a component of fresh fruits, which in turn is a component of fresh fruits and vegetables.

Table 1: Relative importance of Components in the Consumer Price Index (CPI-U).

Item	**Weight**	**Weight**
Food and beverages		15.6
At home	8.3	
Away from home	6.2	
Alcohol beverages	1.0	
Housing (including utilities)		40.9
Apparel and services		4.2
Transportation		17.3
Vehicles	8.2	
Gasoline	3.1	
Other (parts, repair, insurance, public transport)	6.0	
Medical care		6.0
Recreation		5.9
Education and communication		5.8
Education	2.8	
Communication	3.0	
Other		4.4
Total		**100**

Source: Consumer expenditure survey.

Note: Individual items may not add to totals because of rounding.

With these expenditure weights at hand, it still takes a high-quality, expensive operation to track the prices. And whose prices? For commodities purchased where and how? In the United States, there are two closely related consumer price indexes. One measures the change in a weighted average of consumer prices, with the base year expenditure weights, for a typical urban family, the so called CPI-U. The other, not quite identical, construct is the CPI-W, which measures prices for urban wage and clerical workers. The focus here is on the more widely cited CPI-U. Neither of these fixed-weight indexes accounts for substitution, the fact that consumers substitute away from goods whose prices increase more and toward goods whose prices increase less. The CPI serves, and should serve, many purposes. For example, the CPI is used to measure consumer inflation on a monthly basis; to make cost-of-living adjustments in SOCIAL SECURITY, income tax brackets, and other government programs; to provide price data as inputs to the National Income and Product Accounts (although the Commerce Department now uses its own set of weights and methods to construct its PCE deflator from these raw data).

Figure 1 provides recent data on the U.S. CPI-U. The CPI-U sets the index=100 for the years1982-1984. As the figure shows, the pace of measured consumer inflation has slowed considerably relative to the 1970s and 1980s, has recently been running in very low single digits, and has had considerable less variation than in the high-inflation 1970s and early 1980s. People change their spending patterns over time, and do so specifically in response to changes in relative prices. When the price of chicken increases, for example, people may buy more fish, and conversely. Hence the weights change, and a price index that fails to account for that-as does the fixed-weight base period CPI-overstates the true change in the cost of living.

There are two obvious approaches to weighting the prices. The first uses a fixed-base period weighting: quantity or expenditure weights remain fixed at their base period levels, and then we see what happens to the weighted average of prices as prices subsequently change. An alternative possibility is to use the expenditure weights or quantities in the second period, after the substitution. Economic theory strongly supports the idea of taking an average of these two numbers, a point originally made by the great American economist IRVING FISHER (1922). Since 2002, the BLS has computed a closely related measure called the chained-CPI; it has been rising much less rapidly than the traditional CPI-U, suggesting that the failure to account for consumer substitution explicitly is a serious weakness of the official CPI. Similarly, where people make their purchases changes over time. Discount stores and online sales have become more important relative to traditional small retailers. Because price data are collected within outlets, the shift of consumer purchasing from discounters does not show up as a price decline, even though consumers reveal by their purchases that the price decline more than compensates for the potential loss of personal services. Thus, in addition to substitution bias among commodities, there is an outlet substitution bias. Even when purchases are made can become important. We typically measure prices monthly, during a particular week. But if, for example, consumers get wise to post-Christmas discounts and start buying a lot more holiday items after Christmas, surveys that look solely at prices in the second week of December will miss this. Another problem is that price tend to be collected during the week. In the United States, about 1 percent of price quotes are collected on weekends, despite the fact that an increasing share of purchases is made on weekends and holidays (probably reflecting the increase in prevalence of two-earner couples). Because some outlets emphasize weekend sales, there may be a

"when" bias as well as "what" and "where" biases. This phenomenon may explain, in part, recent research suggesting that prices rise less rapidly in data collected by scanners on actual transactions than in that collected by BLS employees gathering data on prices on shelves and racks.

Finally, an additional bias results from the difficulty of adjusting fully for quality change and the introduction of new products. In the U.S. CPI, for example, VCRs, microwave ovens, and personal computers were included a decade or more after they had penetrated the market, by which time their prices had already fallen 80 percent or more. Cellular telephones were not included in the U.S. CPI until 1998. The CPI currently overstates inflation by 0.8 – 0.9 percentage points: 0.3 -0.4 points are attribute to failing to account for substitution among goods; 0.1 for failing to account for substitution among retail outlets; and 0.4 for failing to account for new products. Thus, the first 0.8 or 0.9 percentage points of measured CPI inflation is not really inflation at all. This may seem small, but the bias, if left uncorrected for, say, twenty years, would cause the change in the cost of living to be overstated by 22 percent.

The U.S. CPI is one of the few economic statistics that is never revised, even if subsequent data reveal that the published statistics is wrong. This is done because many contracts and other government programs are expressly indexed or adjusted to the CPI, and revisions would cause practical and legal complexities. We know that different sets of consumers have different expenditure weights because they spend different fractions of their income on the various commodities: renters versus homeowners, the middle aged versus the elderly, and so on. Interestingly, most analyses find only modest differences in inflation rates across groups with different expenditure weights. What about differences across groups in prices and rates of change of prices? For example, do the prices paid by the elderly differ from those paid by the general population? And if they do differ, have the differences changed over time? Economic theory suggests the prices will not differ much for most items, but we do not have serious empirical evidence on this score.

Thus, inflation – the rate of change of prices – is hard to measure accurately. Government Statisticians in all countries, especially those at the U.S Bureau of Labor Statistics, have made numerous important improvements over the years. Yet, new products are introduced all the time, existing ones are improved, and other products leave the market. Relative prices of various goods and services change frequently, causing consumers to change their buying patterns. Literally hundreds of thousands of goods and services are available in rich, industrialized economies. As we have become richer, our demands have shifted toward services and away from goods, and toward characteristics of goods and services such as enhanced quality, more variety, and greater convenience. But all these factors mean that a larger fraction of what is produced and consumed in an economy today is harder to measure than it was decades ago, when a larger fraction of economic activity consisted of easy-to-measure items such as tons of steel and bushels of wheat. Thus, how to obtain information on who is buying what, where, when, why, and how, in an economy, and then to aggregate it into one or a few measures of price change raises a host of complex analytical and practical problem. Price index research and measurement – at one time considered staid and boring – has undergone a renaissance in academia, think tanks, and government agencies, plus practical improvements in real-time government statistics, will be an ongoing effort of major importance and immense practical consequence for many years to come.

2.4– Sierra Leone Consumer Price Index (SLCPI) Literature review.

The inflation rate for consumer prices in Sierra Leone moved over the past 41 years between -3.3%, and 178.7%. For 2021, an inflation rate of 11.9% was calculated. During the observation period from 1980 to 2021, the average inflation rate was 31.2% per year. Overall, the price increase was 2.03 million percent. Sierra Leone's economic freedom score is 50.2, making its economy the 148th freest in the 2023 index. Its score is 1.8 points lower than last year. The country is ranked 35th out of 47 countries in the sub-Saharan Africa region, and its overall score is below the world and regional averages. When the CPI is rising it means that consumer prices are also rising, and when it falls it means consumer prices are generally falling. In short, a higher CPI indicates higher inflation, while a falling CPI indicates lower inflation, or even deflation. The latest readings stand as follow:

Consumer price index (CPI), and other related rates/figures as at April 2023.

Index	Rate/figure
Consumer Price Index (CPI)	0.4%
Unemployment Rate	3.4%
Payroll Employment	+253,000(p)
Average Hourly Earnings	+$0.16(p)
Producer Price Index – Final Demand	+0.2%(p)
Employment Cost Index (ECI)	+1.2%

Source: US Bureau of Labor Statistics.

According to research conducted by Jackson, Tamuke and Jabbie (2019), Korsu (2014) and Kallon (1994), inflation is a topical concern in the global economy; high inflation is considered a deterrent to economic growth, while also limiting a country's hope of attracting foreign investments. Central banks around the world are continuously setting measures in place to bring inflation under control as stated in their mandates. The process of stabilizing prices is very key in maintaining the value of a country's currency against international currencies, which also depends on a plethora of factors. Most common among the factors that contribute to inflationary pressure in an economy is the exchange rate, which as seen in developing economies like Sierra Leone is very critical in securing citizens' decent living conditions.

In the advent of the Covid-19 pandemic, inflationary pressure has become more of a worry to both developed and developing economies, which is highly attributed to supply-chain disruptions (Santacrea and LaBelle, 2022; Bobeica & Hartwig, 2022), coupled with the continued worries of Covid-19 crises that surround inflationary pressures in the world economy, developing economies around the world, particularly Sierra Leone is likely to witness continued price pressures on account of their high dependence on import to sustain domestic consumption (Bangura, Caulker, and Pessima, 2012). Fragility in the domestic economy, which so far can be attributed to weaknesses in real sector operations, low receipts from export of essential commodities, and fiscal tightness are some of the concerns peculiar to the country's macroeconomic stability (Korsu, 2014; Kallon 1994). The continued state of shock

perpetrated in the global economy, resulting from the emergence of the Covid-19 pandemic has manifested itself as a catalyst for inflationary pressures in the Sierra Leone economy – this will continue to pose risk to the economy given the lean state of real sector operations (Warburton and Jackson). As already emphasized in a recent study carried out by Santacrea and LaBelle (2022), supply-chain disruption of goods and services will continue to take a toll on the Sierra Leone economy through anticipated hikes in prices of inelastic goods like rice, typically considered as the country's major staple diet.

Several studies have been pursued about the root causes and dominance of inflation crises in the Sierra Leone economy, which according to theory is assumed to be more monetary and fiscal issues (Frisch, 1990: 90-91; Friedman, 1972). Notable among these include an empirical investigation by Jackson et al (2020) that t4ested the hypothesis regarding the "*Adoption of inflation targeting in Sierra Leone*". This was done with the view of assessing whether Sierra Leone is fully ready to implement the "*full inflation targeting or inflation lite"* approach. The outcome unearthed from the empirical investigation is also in conformity with a plethora of empirical outcomes (Jackson, Tamuke, and Jabbie, 2019a; Bangura et al, 2013; Kallon's 1994), which shows that inflationary pressures in Sierra Leone are not so much a monetary issue, but largely driven by the country's heavy reliance on imports to support domestic consumption and also a continuum of low receipts from export.

Given the mandate of the Bank of Sierra Leone (BSL Act, 2019) to maintain price (categorized as low and stable inflation) and financial stability, countless efforts have been pursued to monitor inflationary movements in the country amidst prevailing pressures, which seem to be heavily dominated by supply and demand-side challenges. Such approaches have been supported by empirical efforts that incorporate the use of univariate models (ARIMA/ARIMAX), typically used as a standard model by many central banks in developed economies to monitor short-term inflation dynamics, and also structural models (e.g., VAR, ARDL, etc) that monitors dynamic interaction of macroeconomic indicators (Jackson and Tamuka, 2018; Tamuke, Jackson and Sillah, 2018; Jackson, Tamuke and Jabbie, 2019).

To pursue our venture of exploring the above-stated motivation, the researchers have poised to search for an answer to the following research question: *What are the sources and drivers of inflationary pressures in Sierra Leone?* To answer the above research question, we hereby set ourselves to explore the three under mentioned research objectives: *(i) To examine the determinants of inflation in Sierra Leone; (ii) To utilize an econometric technique that explores the determinants of inflation, with attention focused on supply and demand-side pressure.* The motivation and proposed contribution to knowledge for the paper are two-fold : (i) assess the demand and supply-side impact of inflation on welfare status, and (ii) to the best of the authors' knowledge, are perceived to address the topic by factorizing additional indicators and supported by different timelines considered to be equally influential in monitoring the BSL core mandate of price stability.

Inflation is a topic of discourse in Sierra Leone given its impact on eroding decent welfare conditions of citizens and its likely threat to macroeconomic stability. Historically, Sierra Leone enjoyed long-term economic management under British colonial rule (Luke & Riley, 1989). The deterioration of economic well-being could be traced back to the former regime's insistence on hosting the then Organization of

African Unity (OAU) meeting in 1980, which somehow depleted the country's reserve without much scope for diversification in generating sufficient revenues to support buoyant economic management (Kallon, 2004; Luke and Riley, 1989). Inflationary pressure in Sierra Leone could be linked to shocks about civil unrest, economic high unemployment and persistent trade deficit, which started manifesting themselves in the domestic economy as early as the 1980s to the late 1990s. This insecurity is beaconed on the socio-economic crises endemic to the country, which also affected local productivity as real sector operations were almost kept to zero, thereby eroding citizens' hope of decent well-being, and a disincentive on the part of foreign investors to pursue business operations in Sierra Leone (Kallon, 2004, Bangura, Caulker and Pessima, 2012).

Various schools of thought have been proposed to explain the root causes of inflation in the global economy. In general, this can be linked to four established theories – "*Theories of money, keneyssian, cost push and structuralist" (Frisch, 1990).* Each of these is considered valid in accounting for the volatile state of inflation in the global economy. Their influences could be thought of as interlinked, with the emphasis on structural problems endemic to most economies, specific to small open-economy like Sierra Leone. Keynessian theory gained popularity in the 1930s and the understanding is that both the central bank and government intervention should be used to spur economic growth and decent well-being for citizens (Jahan, Mahmud and Papageorgiou, 2014). Keynesian thinking believes that aggregate demand – considered to be the sum of expenditure categorized on the bases of households, businesses, and government – is constructed as a catalyst to economic development and stability. The development of the Keynesian theory is rooted in the Philips Curve which investigated the relationship between changes in money wages and the rate of employment, perceived as an innovation in modern economic thought, particularly about inflation dynamics (Philips 1958).

In contrast, the monetarist approach, akin to the "*Quantity Theory of Money*" is considered critical to human understanding of inflation discourses in macroeconomic foundation – such assertion can be traced back to the 1970s, particularly with the effort of Milton Friedman's theoretical application of two of his popular papers: " *A Theoretical Framework for Monetary Analysts*" 1970 and " A Monetary Theory of Nominal Income" (1971). On reflection of works produced so far that pertain to the monetarist theory of inflation, Frisch (1990): 90 – 91) made tremendous effort to summarize three hypotheses commonly reappearing in theoretical discourses on the causes of inflation and these include: (i) Inflation is, in essence, a monetary phenomenon, (ii) The rate of growth and the acceleration of the money supply explain the rate of inflation and its acceleration respectively. Linking the above discourses to Fisher's version, the monetarist approach can be expressed using a simple mathematical illustration: MV = PT. Where M is the Money Supply, V is the velocity of circulation, P is the Price level and T is transactions, though difficult to measure, it can be constructed as a substitute for National Income, which is equal to the total quantity of goods and services produced.

The third type of inflation addressed in this section is the cost-push theory of inflation. This type of inflation is said to occur when an economy experience some form of negative cost shock – various authors have proffered an explanation about the undying causes of such type of inflation in the economy (Frisch, 1990: Totonchi, 2011). Attributes of cost-push inflation include though are not limited to the following: (i) Commodity price shocks, particularly oil prices on account of incidences like wars

and pandemics as witnessed with the advent of Covid-19, (ii) Increase in agricultural prices, (iii) Rising wage costs and (iv) Exchange rate depreciation / imported inflation. Last but not the list, the Structural Theory of inflation is distinguished from the others on account of structural maladjustment endemic to many economies around the world (Frisch, 1990). From the perspective of western/ developed economies the structural theory of inflation is an attempt to explain the long-run rise in price levels (Streeten, 1962; Baumol, 1967). The structural theory of inflation is also based on the notion that efforts to reduce money wages can be emphatically strong, but almost an impossible venture. In this situation, resistance to wage reduction relative to adjustment in the supply of, and demand for labor across occupations and industrial activities would need to be accomplished through a corresponding rise in wages – an exception to this is workers considered to be in weak market positions. Such a situation of wage inflation as elucidated by Frisch (1990: 157) is said to be proportional to the rate of structural change in an economy.

The above theoretical discourse has provided a platform to examine the sources of inflationary pressures economies experience around the world. The structural theory of inflation seems to be highly common among developing economies and Sierra Leone is no exception to such problems – this could be attributed to structural factors such as weaknesses in real sector operations, the dominance of external shocks, and other factors connected with demand and supply-side pressures (Bangura et al, 2013; Jackson and Jabbie, 2020; Argy, 1970). The next sub-section provides a platform for exploring knowledge acquisition that pertains to empirically published research on the determinants and sources (both supply and demand-side pressures) of inflation.

Korsu (2014) pursued a study to investigate the inflationary effect of fiscal deficit in Sierra Leone using a simulation approach. The study is motivated based on issues about fiscal deficits, the rising government debts and monetization of fiscal deficit that have become major concerns of policymakers and academics in the Sierra Leone economy. It is thought that the persistence of fiscal deficit, which seems to have gained traction since the 1970s has resulted in expansionary monetary policy – an incitement of inflationary pressure on the economy that also defeats the core mandate of price stability. The study utilized annual data from 1971 to 2012, with ARDL as the estimation model to account for dynamics (lag impact of variables) on inflation. In addition, policy simulations were carried out for the period 2015 – 2017, with unit root tests indicating that all variables are stationary. The estimation outcome showed that inflation is determined negatively by real GDP growth and positively by both money supply growth and exchange rate depreciation. Policy recommendations from the study noted the following observations: (i) that in the interest of attaining low inflation, the conduct of monetary policy and the underlying budget deficit will depend on the degree of exchange rate depreciation and the real GDP growth in the economy.

Bane (2018) investigated the dynamics and determinants of inflation in Ethiopia using annual data from the National Bank of Ethiopia (NBE), the Central Statistical Agency (CSA) and the Ministry of Finance and Economic Cooperation (MOFED). The methodology utilized was ARDL, with emphasis on the monetarist and structuralist views of inflation. The study outcome showed that the major determinants and dynamics of inflation in Ethiopia are both monetary sector and structural factors. The ARDL, model indicated monetary determinants of inflation to include money supply and the real interest rate. The

outcome specifically proved inflation to be both a monetary (proxied by money expansion via credit money printing; government spending and the real interest rate) and structural phenomenon (mainly agricultural shocks). The main recommendations from the study point to the fact that the government of Ethiopia should adopt conservative fiscal and monetary policies, while at the same time enhancing the scope for growth, which has implications for reducing inflationary pressures.

Anaman (2019) examined the factors underlying the inflationary phenomenon in Ghana using annual data that spanned from 1979 to 2016. The study seems to have added to the body of existing literature on inflation through the identification of short and long-run factors, which are thought to influence the inflation trajectory in Ghana. The study utilized Autoregressive Distributed Lag (ARDL) approaches in a bid to establish where both the short and long-run determinants of inflation is based. The empirical outcome showed that price level, in the long-run, is significantly determined by food crop production, crude oil prices, population, the output of goods and services and money supply. While in the short run, interest rate (proxied by policy rate) is the only variable that does not impact significantly on the price level. Error correction outcome (indicated at 60 percent) showed that the system adjusted itself to equilibrium level every quarter. The final recommendation from the study stipulated that policymakers must pay a high level of attention to supply-side issues in the economy rather than focusing attention on the normal orthodox approach to monetary policy.

Inim, Samuel & Prince (2020), pursued an empirical estimation to investigate other determinants of inflation in Nigeria with quarterly data spanning January 1999 to December 2018. The study examined other determinants of inflation in the country using the Autoregressive Distributed Lag (ARDL) method. The empirical outcome showed that poor infrastructural development, exchange rate, political instability, corruption, and double taxation significantly investigate inflationary pressure and not necessarily money supply. The outcome, which showed long and short-run relationships also manifested a causal relationship between other determining factors and the inflation indicator. Recommendations from the study showed that non-monetary factors that instigate inflationary pressures must be controlled, while a review of security expenditure must be regularly carried out to achieve low inflation, consistent with the single digits inflation target needed to support economic growth and development in Nigeria.

Yildirim (2021) undertook an empirical study to determine inflation expectations in Turkey using the SVAR methodology. The study examined the drivers of inflation expectations, obtained from the market participants' survey in Turkey during the period $2006Q_1 – 2021Q_3$. Short-term recursive restrictions were imposed, which took into consideration a co-dependence of relationship in all variables. The study outcome concluded the following points: (i) that inflation expectation dynamics moved with the instinct to a range of macroeconomic shocks. (ii) that expected inflation trends upwards with a temporary/unanticipated increase on its own, as well as other variables like exchange rate, core inflation, oil prices, food prices, and interest rate shocks. (iii) based on innovation shock from impulse response functions and forecast error variance decompositions, it is observed that variation in the exchange rate is the most significant factor that influences changes in expected inflation over a longer period. Overall, the study outcome showed that exchange rate, inflation expectations shock, and oil prices substantially contribute to deflation expectation inertia in Turkey. Robustness check analysis also

supported the underlying empirical outcome. Finally, the recommendation specifies that the credibility of the Central Bank of Turkey must endeavor to factor inflation in Turkey as set out by the monetary policy committee.

Theoretical framework use decomposition of the price level into tradable and non-tradable goods in the context of the Purchasing Power Parity (PPP) and monetary disequilibrium spillover to domestic prices as the theoretical framework for the estimated inflation model, as adapted from Adu & Marbuah (2011).The choice is based on the following: (i) Goods and services in Sierra Leone fall under tradable and non-tradable goods (iii) Sierra Leone is a small open economy with floating exchange rate regime and it exports are primary products while the imports are goods with inelastic demands, including energy and food imports. Thus, changes in exchange rate expected reflect on domestic price level through the PPP, even where the relationship is not one-for-one.

In this respect, the price level is construed as a weighted average of the price of tradable goods (P_T) and non-tradable goods (P_N) as given in equation (1) in logarithmic form.

$$lnP_t = (\ln P_T) + (1 - \theta)(lnP_N) \quad (1)$$

Where $0 < \theta < 1$ is the weight of the price of tradable goods in the price level.

Thus, according to the PPP, the price of tradable goods is given as:

$$P_T = EP_f \Rightarrow \ln P_T = \ln E + \ln P_F \quad (2)$$

By cancelling out P_f in Eq. 1, this can be rewritten as:

$$P_T = loge \qquad \text{Eq. 3}$$

The price of non-tradable goods, unlike the price of tradable goods, is domestically set given developments in the money market and it moves in tandem with demand in the domestic economy, dictated by money market conditions. Thus, the price of non-tradable goods is determined by the money market disequilibrium. That is, given that money supply is M_S and money demand is M (M_d), the price of non-tradable goods is:

$$P_N = \lambda(\log M_S - \lambda \log M_d) \quad (3)$$

Where, λ is the scale factor representing the relationship between economy-wide demand and the demand for non-tradable goods. The demand for money is considered to depend on t on real income (y), interest rate(r) and inflationary expectations ($E(\pi)$). Where income is the scale variable and interest rate is the opportunity cost variable as in equation (4).

$$M_d^t = f(y, r, E(\pi)) \quad (4)$$

Where y is real income, r is the nominal interest rate and (π) is the expected inflation rate, proxy by Risk Premium for this study. Economic theory in this case postulates a positive relationship between money demand and real income on one hand and money demand and expected inflation rate on the other hand (Adu and Marbuah, 2011). On the other hand, we also note from economic theory that there exists an inverse relationship between demand for real money balances and the interest rate. In addition to Adu and Marbuah (2011) study, we also seek to apply our understanding from Ubide (1997) and Laryea and Sumaila (2001) studies in postulating a general formulation of inflationary expectations common to Sierra Leone, hence resulting in the initiation of Eq. 6.

$$(\pi_t) = (\ L(\pi_t)) + (1 - y)\,\Delta logP_{t-1} \qquad \text{Eq. 6}$$

Where L(π_t) represents a distributed lag for agents in the economy, with backwards-looking expectations, thereby equating the distribution parameter for the process to zero (that is g = 0). This now restates equation (6) in a simplified format as shown below in Eq. 7:

$$(\pi_t) = \Delta logP_{t-1} \qquad \text{Eq. 7}$$

With the substitution of Eq. 7 into Eq. 4 and then utilizing the results and also, Eq. 3 into Eq. 1 - rearrangement then produces a new price level expression as indicated in Eq. 8:

$$P_t = (\ \pi_t,\ E_t,\ M_t,\ r_t,\ P_{t-1}) \quad \text{Eq. 8}$$

An important macroeconomic indicator that is considered influential to inflation outcome and expectations in Sierra Leone is the fiscal deficit (FD). Fiscal deficit normally leads to a temporary form of disequilibrium in the money market, which takes the form of increased use of currency in circulation, and backed by a follow-up process of an increase in lending rate in a bid to divert private sector resources to fund public sector operations. This then results in the augmentation of Eq. 7, with the incorporation of a FD indicator that accounts for the effect of deficit financing, which also spurs inflationary pressure in a country like Sierra Leone where the real sector is practically unproductive to address domestic demand.

$$P_t = (\ \pi_t,\ E_t,\ M_t,\ r_t,\ FD,\ P_{t-1}) \qquad \text{Eq. 9}$$

Reasons for the Double Digit Inflation

A. Prices of food and non-alcoholic beverages, clothing and footwear, alcoholic beverages, tobacco and narcotics and restaurant and hotels services continue to significantly contribute to consumer price inflation in the country. There are many reasons why high inflation may persist; and cause can be both external and internal.

B. In 2008 for example, the global food and fuel crisis, which saw sudden and sharp increase in the price of food and fuel in the global market, was translated into high inflation, especially in Sierra Leone, which is a net importer of food and fuel.

C. Furthermore the formation of cartels by producers, importers and suppliers of basic goods like rice, fuel, flour, cooking oil, drinks, tobacco and other items, ensures that sellers have limited monopolies over the domestic price., which sometimes perpetuate profiteering at the expense of the welfare of the consumers.

D. In addition, artificial scarcity of domestic goods like palm oil, pepper, vegetables, etc. in urban markets due to transportation difficulties also cause inflation as the limited supply will attract a higher price in the market until new stocks arrive in those markets.

E. The depreciation of the exchange rate against the US Dollar is also a strong cause of inflation in Sierra Leone. Although the exchange rate is stable now (or even appreciating) it takes time for sellers to lower their prices since they always anticipate a sudden increase in the rate and to avoid a loss in the event the exchange rate goes up.

Limitation of the Sierra Leone Consumer Price Index Report

The CPI reports covers only the national CPI series, which is an average of the regional CPIs. Therefore, this report excludes the old CPI series with 1992 base year, which uses Freetown index as a proxy for the national index.

The Sierra Leone CPI is still urban-based thus the rural trend although captured in the urban centers, it is not totally reflected in the urban series.

Coverage of Urban centers is still low; for example, the entire Northern Province and the entire Southern Province and Western Area are only covered by one urban center Makeni, Bo and Freetown respectively.

The Real Gross Domestic Product (LRGDP), Fiscal Balance, Currency in circulation, and Lending Rate all have a bearing on the inflation rate and are defined as follows.

Real Gross Domestic Product (LRGDP): This indicator is a measure of the value of economic outputs, which is adjusted for price changes (in short, inflation or deflation). This adjustment portrays an indication of the value of money measured in nominal GDP terms, and typically as total output. In short, the GDP comprises: "*consumer spending*, *industrial investments*, *excess of exports over imports and government spending*".

Fiscal Balance (FB): Is the difference between the Total Revenue and Total Expenditure of a country. It gives an indication of the government's appetite to spend, which is motivated by various factors - in general, government's borrowing

appetite may also be dictated by the fact that a country may not be sufficiently capacitated to generate enough revenues to meet planned expenses and hence, the outcome to access funding is through domestic funding - typical example in the case with Sierra Leone is through the money market (technically the T-Bills).Where the scope of borrowing is not fully met by the commercial banks, the central bank may step in, which is also a catalyst for inflationary pressure.

Currency in Circulation (LCiC): Based on Fig. 8, CiC is the amount of money that is represented in paper form or coins within a country, considered physically in use to conduct a transaction by customers and businesses. More specifically, CiC is all of the money issued by the Bank of Sierra Leone less cash removed from the banking system. It is part of the total money supply in a system, of which the remaining parts will have already been stored in checking and savings account. A fluctuating rise in CiC, which also relates to continued pressure in the exchange rate market and the need for consumers to demand more money to address their wants.

Lending Rate (LR): Concerning Fig. 9, LR is the amount that is charged by lenders, particularly high street commercial banks for a given period as a percentage of the amount lent or deposited by a customer. In most cases, the total interest charged will depend on the duration of the service or even the status of the customer (classified as high or low risk). The lending rate as provided in is a reflection of the rate charged by commercial banks in Sierra Leone over the study period, which is 2010M1-2021M12. On reflection, rates moved to their lowest around 2017 and IN 2020, which could be on account of some shock in the economy and the BSL's unconventionalMonetary Policy measure to cushion the adverse impact of the COVID-19 pandemic on citizens' welfare.

Chapter 3: Methodology

3.0 The Consumer Price Index. The CPI is an index that measures the rate at which the prices of consumption goods and services are changing from one period to another. The prices are collected from shops or other retail outlets. The usual method of calculation is to take an average of the period-to-period price changes for the different products, using as weights the average amounts that households spend on them. CPIs are official statistics that are usually produced by NSOs, ministries of labor, or central banks. They are published as quickly as possible, generally within four weeks after the reference period. The Manual is intended for the benefit of agencies that compile CPIs, as well as users of CPI data. It explains in some detail the methods that are recommended for use to calculate a CPI. A separate companion publication,

3.0.1Consumer Price Index Theory. Explains the underlying economic and statistical theory on which the methods are based. A CPI is a measure of price changes of the goods and services purchased by households in their role as consumers. It is also widely used as a proxy measure of inflation for the economy as a whole, partly because of the frequency and timeliness with which it is produced. It has become a key statistic for purposes of economic policymaking, especially monetary policy. It is often specified in legislation and in a wide variety of contracts as the appropriate measure for adjusting payments (such as wages, rents, interest, social security, other benefits, and pensions) for the effects of inflation. It can therefore have substantial and wide-ranging financial implications for governments and businesses, as well as for households. This Manual provides guidelines for NSOs or other agencies responsible for constructing a CPI, bearing in mind that the resources available for this purpose are limited. Calculating a CPI cannot be reduced to a simple set of rules or standard set of procedures that can be mechanically followed in all circumstances.

While there are certain general principles that may be universally applicable, the procedures followed in practice, whether they concern the collection or processing of the prices or the methods of aggregation, must take account of particular circumstances. These include the main use of the index, the nature of the markets and pricing practices within the country, and the resources available to the national statistical office (NSO). NSOs have to make choices. The Manual explains the underlying economic and statistical concepts and principles needed to enable NSOs to make their choices inefficient and cost-effective ways and to be aware of the full implications of their choices. The Manual draws upon the experience of many NSOs throughout the world. The procedures they use are not static but continue to evolve and improve in response to several factors. First, research continually refines and strengthens the economic and statistical theory underpinning CPIs. For example, clearer insights have recently been obtained on the relative strengths and weaknesses of the various formulas and methods used to process the basic price data collected for CPI purposes. Second, recent advances in information and communications technology, such as the availability and the technical capabilities to make effective use of large-scale administrative data sets, have affected CPI methods. Both of these theoretical and data developments can impinge on all the stages in compiling a CPI. New technology can affect the methods used to collect prices and transmit them to the NSO. It can

also improve the processing and checking, including the methods used to adjust prices for changes in the quality of the goods and services covered. Finally, improved formulae help in calculating more accurate and reliable higher-level indices, including the overall CPI itself.

3.0.2 International Standards for Consumer Price Indices. The objectives of the international standards for CPI compilation are to provide guidelines on best practices that can be used by countries when developing or revising a CPI and to promote the quality and international comparability of national CPIs. In many countries, CPIs were first compiled mainly to be able to adjust wages to compensate for the loss of purchasing power caused by inflation. Consequently, the responsibility for compiling CPIs was often entrusted to ministries, or departments, of labor. The International Conference of Labor Statisticians (ICLS), convened by the Governing Body of the ILO, therefore provided the natural forum in which to discuss CPI methodology and develop guidelines.

The first international standards for CPIs were promulgated in 1925 by the Second ICLS. The first set of standards referred to "cost of living" indices rather than CPIs. A distinction is now drawn between two different types of indices. A CPI can be defined simply as measuring the change in the cost of purchasing a given "basket" of consumption goods and services, whereas a cost of living index is defined as measuring the change in the cost of maintaining a given standard of living, or level of utility. For this reason, the Tenth ICLS in 1962 decided to adopt the more general term "consumer price index," which should be understood to embrace both concepts. There need not be a conflict between the two. As explained in the Manual, the best practice methods are likely to be very similar, whichever approach is adopted.

The international standards for calculating CPIs have been revised four times, in 1947, 1962, 1987, and 2003 in the form of resolutions adopted by the ICLS. The 1987 standards on CPI were followed by a manual on methods (Turkey and others 1989), which provided guidance to countries on the practical application of the 1987 standards. The 1989 manual on methods was revised, expanded, and published in 2004. The 51st Session of the United Nations Statistical Commission endorsed this Manual as an international statistical standard on March 4, 2020 and urged all countries to use this Manual in the compilation of their national CPIs.

3.0.3The Background to the Present Update. Since 2004, substantial progress has been made in developing new data sources, price collection methods, and related index calculation methods. This update incorporates these developments and reflects experience gained improving CPI compilation methods. Finally, evolving user needs and the need for greater international comparability contributed to the necessity for updating the 2004 Manual. In response to the various developments in CPI compilation methods and the emergence of new data sources, the need to update the 2004 Manual was recognized and agreed in 2014. A formal recommendation to revise the manual was made at the meeting of the UNECE Expert Group on Consumer Price Indices, Geneva, May 2014, jointly organized with the ILO. The participants of this meeting noted a need for clearer, more prescriptive recommendations where research, methodological development, and practical experience support such recommendations and guidelines.

Following the 2014 meeting in Geneva, the IWGPS endorsed the need to update the Manual and selected the IMF as lead agency to manage the update. The overall objective of this update was to develop a more concise manual that provided more practical advice wherever possible. The

updated material takes into account experiences gained on the applicability and usefulness of the 2004 Manual; incorporates relevant developments in methods and practices as well as theory and research over the last decade; updates material on data sources, data collection methods, and related calculation methods to reflect developments since 2004; reflects recent developments in user needs; and harmonizes the CPI concepts in line with the *System of National Accounts 2008*.
The Organization of the Update. The six international organizations listed at the beginning of this preface, concerned with the measurement of inflation, have collaborated on the update of this Manual. They have provided, and continue to provide, technical assistance on CPIs to countries at all levels of development. They joined forces to establish the IWGPS to develop international standards and recommendations on price statistics, document best practice guidelines, and support their implementation.

3.0.4 Developing the Consumer Price Index. CPIs measure changes over time in the general level of prices of goods and services that households acquire (use or pay for) for the purpose of consumption. In many countries, they were originally introduced to provide a measure of the changes in the living costs faced by workers, so that wage increases could be related to changing levels of prices. However, over the years, CPIs have widened their scope and now are widely used as a macroeconomic indicator of inflation, as a tool by governments and central banks for monetary policy and for monitoring price stability, and as deflators in the national accounts. With the globalization of trade and production and the liberalization of the markets, national governments, central banks, and international organizations place great importance on the quality and accuracy of national CPIs, and their international comparability. Different conceptual frameworks can be used to address fundamental issues relating to the nature of the index. For example, different concepts are used if the CPI intends to measure the change in the cost of a fixed-weight basket of goods and services or whether the target is to measure the change in the cost of living, that is, the cost of maintaining a given standard of living, taking into account the fact that when prices change consumers change their expenditure patterns. The use and conceptual basis of the index will determine the method of construction. The method of construction also allows (or should allow) CPIs to be adapted for a wide range of specific uses. For example, they can be adapted to calculate specific inflation rates for social groups such as pensioners

3.0.5 Overview of the Consumer Price Index Concepts: Type of Index Number Formula. Experts generally agree that the ideal type of index for a CPI would be a "superlative" index such as the Fisher index, which will be discussed in the following text. Superlative indices make equal use of the prices and quantities (that is, the expenditure weights) in both periods being compared (the reference period and the current period). Current period expenditure weights are usually not known, so in practice nearly all CPIs rely on weights relating to a weight reference period some time earlier. An exception to this are actual transactions that can be captured at the points of purchase through the use of scanner data. Some countries aim to produce a COLI. But such an index is in fact a type of superlative index and suffers from the same practical defect as mentioned previously, and it is not possible to compile in real time. Many countries state in their published metadata that they use a Laspeyres index or a "Laspeyres-type" index for their national CPI which, in practice, is not the case. It is important, nevertheless, for NSOs to state publicly what type of index is being calculated in their CPI. A true Laspeyres index uses quantity data which relate to exactly the same period as the price reference period. In practice, however, this is

difficult to obtain and rarely the case. Most NSOs have a price reference period which is later than the period to which the quantity data or weights relate. Also, the weights usually will span, say, a year rather than a month (or quarter). This is because one of the main sources of weights data is a household budget survey (HBS), which, ideally, run for 12 consecutive months. The HBS generally produces usable results a year or more
after the end of a survey period.

3.0.6 Index Formula at Lower (Elementary Aggregate) Level. The first stage in the calculation of CPIs is the calculation of elementary price indices, which are then aggregated to obtain higher-level price indices. Expenditure weights are not usually available below the elementary aggregate level. The three most widely known elementary index formulas are the Carli, the Dutot, and the Jevons. These are all based on unweighted averages of prices or price relatives, and each is associated with a number of assumptions which will have an impact on measured inflation. The Carli (a simple arithmetic average of price relatives) and Dutot (the ratio of simple arithmetic averages of prices) formulas have a number of problems associated with their use—particularly the chained Carli, which is discouraged as it is particularly associated with having a known, and potentially substantial, upward bias. The Jevons formula (the ratio of simple geometric averages or the geometric average of price relatives) is increasingly used as it avoids many of the problems associated with the arithmetic versions. It should be noted that an arithmetic average is always greater than or equal to a geometric average and that the difference will be greater, the greater the variance in the price relatives. The choice of formula becomes more important the greater the to ensure that it fulfills its purpose. In this connection, user consultation is important. This section reviews the various uses of a CPI before examining some of the issues confronted by the index compiler relating to the scope of the index and the practical measurement and compilation decisions which must be made.

3.0.7 The Different Uses of a Consumer Price Index. CPIs have three main uses: ***Indexation*** **A** CPI may be used for wage or contract indexation of any specific group, whether of a population acquiring products, or of a subset of products themselves. In either case, it should represent the coverage of the group concerned. For instance, it can be argued that the weights of a CPI used for indexation of pensions should cover only the expenditure of the pensioner population. The product and outlet list could also be more appropriately targeted, if the data exist. This means, for example, that a CPI used for indexing pensions may use weights relating to pensioner households and may exclude products which may be thought largely irrelevant to this group of households such as educational items. Similarly, for domestic indexation, the CPI should cover only expenditure of the resident population (see Section on Geographical Coverage and Chapter 2 for more information). More generally, it must be decided whether the CPI should be, in principle, a cost of living index (COLI) or a cost of goods index—these two very different concepts are discussed in the following text. For certain specific types of indexation, such as for rents, users may prefer to use just the sub index for rents. In such cases, the sub index should be of a statistical quality sufficient for that purpose.

3.0.8 National accounts deflation. This use requires consistency between the price data used for the CPI and the expenditure data used in the national accounts. Both data sets should cover the same set of goods and services and use the same concepts and same classification, in principle the Classification of Individual Consumption According to Purpose (COICOP). For example, the

national accounts require the valuation of goods produced for own consumption, whereas this is sometimes excluded from the CPI either as a matter of principle or for pragmatic reasons. This applies mainly to the valuation of the services of owner-occupied housing and the consumption of own-produced food.

3.0.8 Inflation measurement. It can be argued that central banks ideally need a timely index relating to total inflation, not just consumer inflation. But NSOs generally are unable to construct such indices, in part because of the measurement issues relating to government consumption. In the absence of such an index, most central banks rely on a CPI, using the domestic concept, but measured on as wide a basis as possible, with regard to both products and geographical coverage. The same applies to the use of the CPI as a general macroeconomic indicator. Consumption is likely to take place in the month for which the CPI is calculated. But a semi durable good such as a shirt will be worn many times over a period *of a* decade or more. The question arises as to which CPI month (or months) should the purchase be allocated. With services, these questions can be even more complex. Take, for example, the purchase of a season ticket for a bus service. This may be a single payment for a pass which gives ("free") unlimited bus transport for a year. It can be seen that although this example is clearly a service (the use of bus transport over a period of time), it has much in common with the purchase of a durable or semi durable good such as a television or shirt which provides a type of service over a long period. A service such as a medical operation can also be regarded as durable, since it is likely to give long-term health benefits to the patient. CPI theory devotes much thought to these issues, which can have important implications not only for how a CPI is compiled but also for the results. Three different approaches can be identified:

***The *acquisitions approach.* *R*elates to when the good or service is acquired, irrespective of when it is actually used or consumed. The time of acquisition of a good is the moment at which the legal ownership of the good passes to the consumer. This is usually the point at which the purchaser incurs a liability to pay. On the other hand, with a service there is no change in ownership; it is "acquired" at the time the producer provides it (for example, a single bus journey or airline flights). A CPI based on this approach measures the change in the cost of acquiring a product. The timing of the recorded prices should be consistent with the way in which the value would be recorded in the expenditure data used for the CPI weights.

The *use approach. Relates to the period over which the product is consumed or used. A CPI based on this approach measures the change in the cost of using the product over time; in other words, the cost of the good is distributed over its useful life. Expenditures on durable goods and services are liable to fluctuate depending on the expected duration of their useful life.

***The *payments approach.* *R*elates to the period of time when the actual period-to-period payments for the product are made. This can differ from the period when it is acquired and when it is used. When payments are not made in cash, there may be a long period before the purchase is paid for, whether by credit card or other methods. The time at which these debits are made is irrelevant for the recording of the price. The price to be recorded is the price payable at the time of acquisition (though sometimes the method of payment may itself affect the price). NSOs need to have a clear policy on which of these approaches is used in their CPI. In practice, the choice between the three approaches is an issue relating to durable goods and its impact is likely to affect the weight given to owner-occupier housing costs. In countries where food expenditures

and other expenditures on nondurables, semi durables, and services diversity of price movements which is one argument for ensuring that elementary aggregates are as homogeneous as possible.

3.0.9Index Formula at Higher Level. The higher-level indices are calculated simply as weighted averages of the elementary price indices. The weights typically remain fixed for a sequence of at least 12 months. Some NSOs revise the CPI weights at the beginning of each year to try to approximate as closely as possible the current consumption patterns, but many countries continue to use the same weights for several years. At a minimum, weights should be updated every five years. The use of fixed weights has a considerable practical advantage that the index can make repeated use of the same weights. This saves time and resources. Revising the weights can be both time-consuming and costly if it requires a new HBS to be carried out. However, the longer the period between weight updates, the less relevant and representative the CPI becomes. Many NSOs are moving toward annual or biannual weight updates.

3.0.10Consumer Price Index Theory. The superlative indices Walsh, Fisher, and Törnqvist show up as being "best" in all the approaches to index number theory. These three indices give very similar results so that for any practical reason it will not make any difference which one is chosen as the preferred theoretical target index because they most closely approximate a COLI. The theoretical target index is a matter of choice and affects the choice of formula used to calculate the index. In practice, an NSO may prefer to designate a basket index that uses the actual basket in the earlier of the two periods as its target index on grounds of simplicity and practicality. As noted previously, it is not possible to compile a superlative index in real time. In other words, the Laspeyres index may be the theoretical target index because NSOs produce a CPI that lies between a COLI and a cost of goods index.

3.0.11Acquisition, Use, or Payment Approach. A CPI is based on the measurement of the change in prices of the goods and services included in the basket. The vast majority of goods (but not necessarily of total values) are priced in the retail outlets selling them. It should be noted that most often the prices recorded are the labeled prices, which are assumed to be the prices actually paid by consumers. It is also generally assumed that payment for the goods is made at the time of purchase—indeed the consumer would regard the two events as identical. However, payment can be in cash or on credit, including credit cards for which the due date of payment may be several weeks after the actual purchase.

The time factor is important also in other ways. A consumer may decide to buy a larger than normal quantity of a particular good if there is a special price reduction. The product may then be stored at home and "consumed"(that is, used) over a relatively long period. Cans of food, for example, offered cheaply for a limited period, may be stored at home without deterioration for months, and consumed at the usual frequency. Another issue concerns the definition of "usage." A bottle of milk will typically be consumed within countries on a continuous basis, although surveys of prices done in order to compute purchasing power parity may provide an occasional benchmark. Where the regular collection of the relevant prices is not practical, it may be possible to obtain a reasonable proxy for price movements using published sub-indices of the other countries' CPIs.

Under the domestic concept, the treatment of internet purchases requires a broader approach, especially given its growing importance. Most NSOs which have examined the issue have concluded that internet purchases from home whether from domestic or foreign websites, should be included in the CPI. Care must be taken to convert foreign purchases to the national currency as differences in exchange rates will affect the price paid.

3.0.12 Regional Coverage. Concerning the regional coverage of the CPI, the general rule is that a national CPI should cover expenditures and prices throughout the country. However, comprehensive coverage is not always necessary, especially if regional CPIs are not published and the sampling program ensures that the index is representative of the whole country. In such situations, CPI compilers should collect evidence from time to time on the trends in prices in different regions over periods which cover differences in seasonal variations, to ensure that the sample remains representative. Any region which shows price trends significantly different from the others should be covered by the CPI if its inclusion is likely to have a significant effect on the national CPI and will improve representativeness. But there is little point in spending scarce resources collecting prices in sparsely populated regions if that would have little or no impact on the national CPI. When carrying out these sensitivity tests, regional weights can often be an issue. In this case, population may sometimes be used as a proxy for regional consumer expenditure. However, where regional CPIs are aggregated to compute the national CPI, weights should be based on regional expenditure rather than population data.

Another difficulty regarding regional CPIs is related to the national versus domestic concept. It can sometimes be the case that a household lives in one region but does most of its shopping in an adjacent region, particularly when a household lives close to a regional "border." The question of whether the expenditure weights and the prices should be allocated to the region of expenditure or the region of residence is usually dictated by practical issues. As with the national concept discussed previously, if the region of expenditure is used (equivalent to expenditure abroad by a domestic resident) some method must be found for estimating the proportions of expenditure made by "visiting" consumers in the various regions so that this can be reflected in the price indices. Finally, the question often arises as to whether a CPI can be limited to urban areas or if rural areas should also be covered, as in many countries a significant part of population resides in rural areas. Having a rural CPI is important for poverty analysis. Again, in principle, the whole territory should be covered, but clearly, the impact on the national account for a significant share of the CPI basket and where credit financing is rarely used, the acquisition, use, and payment approaches will give very similar results and hence the CPI can satisfy many uses equally well. This is the principal reason why most countries use, either implicitly or explicitly, the acquisitions approach to define what constitutes
consumption expenditure.

3.0.13 Geographical Coverage. There are two distinct aspects to the question of the geographical coverage of a CPI. The first relates to the country as a whole (domestic versus national coverage), the second to its regions.

****The National versus Domestic Concept***. A CPI can have "national" or "domestic" coverage.

National coverage means that the CPI should cover the expenditure made by resident households (at purchasers' prices) of the country, regardless of where the expenditure takes place. The national concept is appropriate when the CPI is being used for indexation of incomes and cost of living measures. The weights for expenditure abroad can be included in the HBS, but measuring prices paid abroad poses problems. The national concept thus poses a measurement problem for collecting prices abroad.

***Domestic* coverage** means that the CPI would cover all the expenditure made within the economic territory of the country, including the household final consumption expenditure made by foreign visitors. It is appropriate where the CPI is used for national inflation analysis and monetary policy. Many countries carry out surveys of the expenditures of foreign visitors, for example, via International Passenger Surveys conducted at major border crossings and airports by NSO staff. This is particularly important for those countries which have a large number of foreign tourists, or a high level of cross-border shoppers. Foreign visitors will generally have very different expenditure patterns from those of resident households (for example, they will spend more on hotels and restaurants) and to omit them could introduce serious distortions into a CPI aiming to follow the domestic concept, especially if the main purpose of the index is to measure the inflation trends in the economy.

For the national concept, internet purchases from foreign websites or websites of retailers based abroad should be included in the CPI. So should purchases made abroad more generally, including such items as fees for foreign boarding schools, even if the item, in this case education, is consumed outside the country. Where such purchases are made in the foreign currency, they should be converted to the domestic currency at the relevant exchange rate. Clearly, it would be impracticable to collect prices directly in foreign currency. In considering the practical issues relating to the inclusion of institutional households in a CPI, two questions need to be asked. First, is the expenditure pattern of institutional residents likely to be significantly different from household residents? Second, even if the answer is yes, would their exclusion from the CPI be likely to significantly affect the national (or regional) CPI? To answer these questions, some research should be carried out on a sample basis.

Some countries exclude certain household types from the CPI, such as the very wealthy or the very poor. Such exclusions may be on theoretical grounds (for example, using the argument that the expenditure of the wealthy, who are relatively few in number, should not be allowed to affect a CPI which may be used for indexation of wages of ordinary workers) or on practical grounds (for example, using the argument that wealthy households tend to have low response rates to HBSs, and their inclusion can lower the quality of expenditure weights). Such exclusions make the CPI inconsistent with the national accounts coverage. For a CPI which is used for indexation of wages, the exclusion of pensioners and wealthy households may be justified on conceptual grounds. For example, it may be considered that such households are likely to spend their money on atypical products and including them would distort the relevant overall average. It is also argued by some that pensioner households should be excluded in principle from an index used for the escalation or indexation of state pensions because of the circularity involved (the level of state pension influences expenditure patterns which are then used in the up-rating calculation) while others would argue that it is logical that indexation should be based on an index reflecting the expenditure of pensioner households and their specific inflation experience. Note that if

wealthy households are excluded, the CPI basket should not include products likely to be bought only by the excluded group, nor should outlets specializing in such products be included in the sample. Conversely, if the wealthy are included, some "luxury" products and outlets should also be included in the sample. For the analysis of national inflation, it is considered that the more comprehensive the CPI, the better.

Democratic versus Plutocratic Weights. A "democratic" CPI uses weights based on the average proportionate share that households in the whole population have spent on the item. Hence, the share of a specific item in the basket is calculated for each household. The weight for the item is the sum of the household shares divided by the number of households. Many households may purchase the item, but also, a number of households will not make such purchases. The average share is thus based on the experience of each individual household, whether they have purchased the item or not. Each household share is equally weighted in deriving the average. The alternative "plutocratic" CPI calculates the item shares as the total expenditure on the item by all households divided by the total expenditures of all items purchased by households. This latter method gives more weight to the high-spending households. It is argued that a democratic index is more suitable for showing the impact of inflation on the average household but is very rarely compiled by NSOs. There is a consensus that a plutocratic index is the appropriate index to use for national accounts deflation and for a general measure of inflation.

CPI of including rural areas where relatively few monetary transactions take place will often argue against their inclusion on grounds of cost. The view taken will depend, at least
in part, on the size and treatment of own-account production. If own-account production is included in the CPI, the weights should include a valuation of the physical quantities of such products, often derived from the HBS. The prices will normally be the same as those used for actual transactions for the same goods sold in the same locality. Where the weights derived from an HBS are available for rural as well as urban households it is generally better to use the weights for urban and rural households combined, even if price collection is limited to urban areas, as this will normally improve the representativeness of the index. But, where feasible, price statisticians should undertake pilot calculations to test whether this is the case.

3.0.14 Reference Population for the Consumer Price Index. The group of households included in the scope of a CPI is referred to as the "reference population." According to the *2008 SNA*, households are made up of private households and institutional households.

Private households are defined as groups of persons who share the same living accommodation, who pool some or all of their resources and consume select goods and services collectively. Members of the same household do not necessarily have to belong to the same family, as long as there is some sharing of resources and consumption.

Institutional households consist of persons living permanently, or for a very long period of time, in institutions other than private households. These include religious institutions, hospitals, the military, prisons, or retirement homes. Persons who enter such institutions only for short periods of time should be treated as members of the individual households to which they

normally belong. Temporary foreign workers may live together in special housing blocks, which may also be treated as institutional households in the population census.

Expenditure on accommodation and living costs, such as lodging fees and charges for meals, imposed by the institution, as well as personal expenditure by the individual on, for example, clothes and toiletries, should be included in the CPI. However, care should be taken to ensure there is no double counting where, for instance, a family rather than an individual pays the accommodation costs charged to a patient in a hospital. A data source like the HBS should be designed to pick up the amount spent on such charges just once and the standard convention is to record it against the household which incurs the costs. In the previous example, the accommodation costs should be included under the expenditure of the family, and not the individual. If individuals spend their own money on clothes and other incidental expenditure, then the HBS should record this expenditure as being incurred by the individuals. In practice, many HBSs do not cover institutional households and, where this expenditure is considered to be significant, estimates will need to be made from, for example, special surveys of people living in institutions or by reference to the expenditure patterns of similar people, say, the same sex, age, and socioeconomic group, living in non-institutional households. Coverage this category of nonmonetary transaction, so no price should be imputed.

A CPI should measure the prices of final consumption by a household. In principle, the first category, imputed transactions where households do not incur a liability but bear the costs of acquiring the good or service in another way, should be included in a CPI used for deflation in the national accounts compilation and, in principle, can be included in a CPI compiled for other purposes. Perhaps the most important example is the consumption of own-account production products such as food and owner-occupied housing services. Here, there is no actual transaction at all, and thus no price. If the transaction is to be valued, a price has to be imputed. This would usually be done by reference to actual purchases of the same product in, say, nearby markets. But even when this is done for the purpose of national accounts compilation, it is not necessarily appropriate to include production for own consumption in a general-purpose CPI or in a CPI used for indexation. Indices used as a general measure of inflation or for indexation should be based on a narrow definition of consumption that includes only monetary expenditure. From the point of view of measuring inflation and also for the purposes of income indexation, the most common view is that it is best to omit production for own consumption on pragmatic grounds. Furthermore, goods and services purchased by households which are then used as inputs into own-account production are normally treated as if they themselves were consumption goods and services, and therefore are included in the CPI. Some countries may find it useful to produce two versions of the CPI: one including and the other excluding own-account production.

3.0.15 Deciding on the Index Coverage and Classification Structure. Classification is a central theme in the compilation of the CPI. Choosing a classification system is the first step in compiling the CPI because its sub aggregates must be defined in such a way that the expenditure weights and prices will relate precisely to the coverage of the sub aggregates. The classification is also important because it establishes the framework to define and draw the boundaries for the inclusion of the representative items in the index (and sometimes the outlets). Finally, the classification system helps in defining which level of the hierarchy will be suitable for

publication. In years past, countries used their own distinct systems for classifying the range of products covered by their CPI. Most countries have now, however, moved to the international standard classification COICOP.

COICOP was first developed for the *1968 SNA* to provide the structure for classifying household final consumption expenditure. The various components of household final consumption expenditure are often used as the basis for the weights in the CPI. The 2003 International Labor Organization (ILO) Resolution on CPIs requires that national CPI classifications should be reconcilable with COICOP at least at its higher aggregation levels. Most countries have adopted COICOP in their economic statistics (for example, in the CPI, national accounts, ICP, and HBSs), with a clear advantage for integration of data sets and enhanced analytical capabilities. Many countries publish a range of CPIs relating to subsectors of the population such as all households, low income households, or pensioner households, but a CPI based on democratic weights is very rare.

Product Exclusion. In its role as an indicator of total consumer inflation, the CPI should in principle cover all types of goods and services which are consumed in the national retail market. In practice, some types of products may be excluded for policy reasons while other exclusions are unavoidable in practice. These may include: goods sold illegally, such as narcotics; black market sales of mobile phones and other goods; gambling; and prostitution. In most of these cases, except perhaps for legal lotteries, there will be no expenditure data from the HBS and prices are difficult if not impossible to collect. Thus, in principle, estimates of weights and prices will need to be made for the purpose of producing deflators, even if the expenditure is not covered in the CPI. Solutions will need to be found to the practical measurement issues. For instance, if a CPI covers gambling, it is not the gross stakes which should be included in the weight, but the net stakes, which is broadly equivalent to the margin taken by the gambling operator. As it is not likely that the net stakes can be measured, one solution may be to distribute the weight for gambling across other subclasses in COICOP class 09.4.6 (recreational and sporting services).

The treatment of *second-hand goods* is often found to be problematic. As far as transactions within the household sector are concerned, sales will balance purchases, so the weights will be zero, and they may be excluded from the CPI. But in many countries, there are significant sales of imported second-hand goods from dealers and other third parties, such as cars and clothing. Where sales of imported second-hand goods sold by dealers or other third parties are significant relative to sales of new goods of the same product, such sales should be included, in both weights and prices. CPI compilers sometimes face proposals from governments or pressure groups to exclude certain categories of products for non-statistical reasons. Common examples are alcohol and tobacco in some countries where their consumption is socially discouraged or they can only be purchased illegally. While it is acceptable to produce a variant of the CPI excluding such products, the all-items CPI should include them, where practical, to ensure that the index presents a true and accurate picture of national inflation. It covers in some depth the treatment of other excluded or partly excluded products, including taxes and licenses, subscriptions, insurance, gambling, financial transactions, hire purchase, and interest payments.

***Imputed Transactions and Imputed Prices**. A distinction can usefully be made between imputed transactions and actual transactions where a price is imputed. In the category of actual transactions, a prescribed medicine would be provided free as part of a national health service. There is a "transaction" in the sense that a product changes hands but at "zero" price so that it does not constitute a monetary transaction. The conventions for a CPI constructed for the purposes of indexation or the measurement of inflation as a macroeconomic indicator exclude from purpose. Households will select various goods and services in order to satisfy their consumption objectives (that is, renting an apartment for the provision of shelter or eating an apple for the purpose of nourishment). These goods and services are disaggregated further into various groups and may not be based solely on the principle of purpose but also according to product type. For example, oranges and apples are included in the "Fruit" category. The more detailed breakdown is often a product-type classification because these items share a similar production process and are certainly sold at fruit stands or the same location in the supermarket.

***Deriving the Weighting Pattern.** A CPI measures changes in the cost of a representative basket of goods and services. This involves weighting aggregated prices for different categories of goods and services so that each takes an appropriate share to reflect the budgets of the households covered by the index. For instance, if most people spend far more on fresh vegetables than on electricity, then a price rise for fresh vegetables must have more effect on overall price rises than a similar-sized increase for electricity. Therefore, at the lowest level, each elementary aggregate should receive a weight equal to the ratio of expenditure by the covered households on items represented by that aggregate to total expenditure by covered households on all items within the scope of the CPI.

The 2003 ILO Resolution on CPIs makes the obvious but important point that the weights follow directly from the scope of the index as well as from the choice between the "acquisition," "use," or "payment" approach, also states that there are two main sources of information: HBSs and national accounts, and that the weights should be reviewed and updated at least every five years. Additionally, new sources of weight information are being developed such as actual expenditures on various types of transactions based on scanner data and other electronic formats. Such sources are being evaluated and exploited for use in development of weights now and in the future.

The use of expenditure weights is consistent in concept with a CPI based on the acquisition, payment, and user cost approaches although the treatment of major durable goods and housing can present a problem, particularly the costs of owner-occupied housing. The use of weights in a CPI based on total consumption expenditure is often referred to as plutocratic weights because this concept gives more weight to the expenditure patterns of high-spending households (which will also tend to be those with higher incomes). The goods and services consumed by the households can in principle be acquired in four ways: (1) purchase in monetary transactions; (2) from own production; (3) as payment in kind; and (4) as transfers or gifts from other economic units, including social transfers in kind provided by government and nonprofit institutions serving households. The weights are determined by the scope of the CPI and should be derived on the basis of the relevant coverage and types of consumption and with reference to SNA.

***Classification Systems: The General Case.** In its broadest sense a classification is a procedure in which individual items are organized into categories (classes) and subcategories (subclasses)

based on information on one or more characteristics inherent to the items. A classification structure will usually have these same items (or elements) arranged in a hierarchically ordered system based on category–subcategory relationships where the subcategory has the same description as the associated category in addition to one or more descriptions. For example, an apple is a subclass of fruit. So any apple is a fruit, but not every fruit is an apple. A product needs to have a more detailed description to be an "apple" and not just a "fruit." In principle, a classification system can be based on any attribute of the objects being classified. Normally, organizing a population of items into categories must leave no two categories with any item in common; in other words, the categories must be mutually exclusive. Also, the categories must collectively include all of the items which are in the population—the categories must be exhaustive. For example, in the case of the CPI, its classification should include the entire universe of goods and services that are covered by the index (for example, fresh food purchased in a store by a consumer is part of the CPI, while heavy machinery such as a tractor is not) and no product should be included in two different categories in the structure.

3.0.16 The Consumer Price Index Classification System. COICOP, as its name implies, is founded on the principle of "purpose" (see Box 1.1). It is a purpose-type classification because throughout the aggregation program the products are grouped according to the purpose (or function) they usually fulfill such as transport, nourishment, shelter, and so on. Most national CPIs aim at measuring the change of the cost of a basket of goods and services, which is consumed for the purpose of satisfying certain needs. A purpose-based classification would therefore appear to be the logical classification system for a CPI. The official COICOP is a five-digit classification. NSOs will expand the COICOP to six and seven digits to obtain more detail for their use. At the higher level of the classification, the products are grouped according to whether the where the retail market is heterogeneous. Some levels are the following: ***Central shops weights*** to represent a small number of large supermarket chains or chain stores which have uniform prices across branches and prices are provided by the shops' headquarters.

Stratum weights. For some types of expenditure, purchasing patterns may differ markedly by region or type of outlet, and in these cases, stratification will improve the accuracy of item indices. For example, each locally collected item in the index could be allocated to one of the different stratum types to allow the best available information about purchasing patterns to be incorporated in the index calculation. Depending on the structure of the retail market, the stratum types could be: region and outlet type; region only; outlet-type only; and no stratification. The assignment of stratum type will depend on the information available for constructing the weights for each item and the number of prices collected per item. In principle, all locally collected items might be stratified by both region and outlet type, but if the weights data are unreliable or nonexistent at this level of detail, then the item may be allocated to another stratum type. Allocation also partly depends on which outlet types are specified for the collection of prices and the number of prices collected. If the rules for the choice of outlets did not specify that both a chain and an independent outlet should be chosen for an item, there may be too few prices collected in one of these outlet types to make stratification by outlet type meaningful. In some instances, there may be no stratification because research has shown that stratification has little effect.

The weight of an elementary aggregate (that is, the stratum weight) should reflect the expenditure on the entire elementary aggregate and not the weights of the outlets and items that have been chosen to represent it. For instance, if spaghetti is chosen as the representative product under the elementary aggregate with the heading of pasta products, then the weight of this category should reflect expenditures for all pasta products and not solely the "lower" weight of spaghetti; that is, the weight of the pasta category will be represented entirely by spaghetti. Similarly, if an expenditure category is divided into two elementary aggregates according to outlet type, say, open markets and supermarkets, with corresponding market shares of food sales, 70 percent and 30 percent, respectively, then the same rule as mentioned previously should apply. For instance, suppose a single store is selected as the representative outlet for a particular food item sold in supermarkets in a country where two supermarket chains have equal sales, then the sales from the sampled store will account for the total value of the expenditure weight of 30 percent; the weight of the elementary aggregate for this food item sold in supermarkets should not be 15 percent (0.30 × 0.50), that is, a weight based only on the sales of the selected supermarket.

***Product or item weights** (in the current context the terms can be interchangeable). Some products or items may be intended only to represent themselves; others represent a subclass of expenditure within a section. For instance, concepts. But it should be noted that there are several delineations of consumption used. The broadest possible scope for goods and services would cover all four of the previous categories. It would include all social transfers in kind in the form of education, health and housing, and other goods or services provided free of charge or at nominal prices. The total acquisition of goods and services thus described is equivalent to household actual final consumption in the SNA. For the CPI as a general measure of inflation, the more relevant would be to include only goods and services purchased in monetary transactions by the households. Only monetary transactions generate prices that can be observed for the CPI, but this then leaves outstanding the issue of owner-occupier housing services.

It is against this background that a CPI often follows the concept of household final consumption expenditure, as laid down in the *2008 SNA*. This approach is often recommended for a CPI being used as a macroeconomic indicator, restricted to the appropriate reference population, or "Index Households," where the CPI is being used as a compensation index. This compensation index might, for example, exclude the very rich. Household final consumption expenditure includes nonmonetary transactions (such as for owner-occupier housing or consumption of own production of food). The concept of "household final monetary consumption expenditure," used in the European Union Harmonized Index of Consumer Prices defines both the goods and services to be covered, and the price concept to be used, and refers only to monetary transactions. Household final monetary consumption expenditure is a useful concept but many countries prefer to also include some nonmonetary transactions (in particular owner-occupier housing) in their CPI, sometimes using imputed costs thus moving the coverage of the index closer to household final consumption expenditure.

3.0.17 Weighting Structure. The weighting structure should follow the aggregation structure of the CPI. For instance, if this structure is based on COICOP, then this is the structure which should be used for the weights. Additional subdivisions can be introduced where there is further stratification of the sample to include geographic allocation, outlet type, or a more detailed

product level classification. Thus, the weighting structure will depend on the sample design for price collection and compilation and in particular the need for more detailed weights which may be generated by additional sample stratification. In general, NSOs will collect some prices centrally and adopt up to four levels of sampling stratification for local price collection: locations; outlets within locations; items within different sections of expenditure; and varieties. The sampling of varieties is normally conducted in the field by price collectors and does not normally involve explicit weights. Stratification is frequently used to increase sampling and operational efficiency, especially expenditure weights. There are two ways of doing this:

(1) including the weight in a related elementary aggregate (this may involve the creation of a "miscellaneous" category), or

(2) having the weight of the product for which no representative prices exist equal to zero, which essentially redistributes the weight to other elementary aggregates.

In general, the prices for the product for which prices are not collected will be expected to exhibit a similar movement to the other products in the elementary aggregate and the first of the previous two methods should be used. The second method may be used where the elementary aggregate is heterogeneous, or the associated price index is not considered very reliable. Because of the negligible size of the weight value involved, the consequence on the overall index will also be negligible whichever method is used.

***Data Sources.** Depending on the population coverage, weights for a CPI are derived either from expenditure data based on estimates drawn from a sample covered in the HBS or from national accounts estimates of household final consumption expenditure. It should be emphasized, however, that expenditure estimates in the national accounts are usually partially based on HBS information, although they may differ with regard to coverage, and that in some countries these are not available or not compiled at a detailed level. The two sources are not entirely independent. Note also that national accounts data may also be used when the HBS is conducted too infrequently to ensure the reliability of the CPI or when the expenditure weights need to be updated more often than the periodicity of the HBS. Nevertheless, an HBS will still have to be conducted eventually because it is an important source for benchmarking the components of household final consumption expenditure of the national accounts. Other sources for the weights are also available and are usually complementary to these two main sources. These include administrative data sources or retail trade statistics data. When various sources of information are used for generating the weights in a CPI, the compiler should take the time to check the data to ensure that the results are consistent and plausible with what is expected or investigate further if necessary.

****Household Budget Surveys*** When using the HBS as the basis for developing CPI weights, the sample size (number of households) should be sufficient to ensure that the expenditure data yielded produce statistically reliable and representative weights at the elementary aggregate level. In some countries, the acceptable statistical quality is based on the coefficient of variation (the ratio of the standard deviation to the mean). For those expenditure weights that are unable to meet the minimum requirement of reliability, three options should be considered: If reliable expenditure data are not available for an elementary aggregate, they can be combined

with another related elementary aggregate to form a new broader elementary aggregate (for example, “wheat bread” could be combined with “rye bread” to form a new category called within electrical appliances, an electric cooker may represent only itself and not any other kinds of electrical appliances. However, other products or items will represent price changes for a set of products or items, which are not all priced, so for these the weight reflects total expenditure on all products or items in the set. For example, a screwdriver may be one of several items representing all spending on small tools within home improvement and maintenance materials, and there are other items within the section representing all spending on paint, timber, fittings, and so on.

Upper-level or section weights. It is common practice to or per hundred so that the sum of the section weights is 1,000 or 100. It is likely that most of these weights will be based on the HBS results. The main exceptions will be some housing sections, including (where applicable) mortgage interest payments and depreciation, where weights are estimated from other sources, and for certain other sections (for example, tobacco, confectionary, soft drinks, and alcoholic drinks) where the HBS may be thought to under-record expenditure and better data are available elsewhere. Many countries also use national accounts household final consumption expenditure estimates where available at the COICOP group or class level and the HBS expenditure distribution at the lower levels. This is also an area where scanner data can be used to more accurately reflect the expenditure distribution.

Implicit Weights Within Elementary Aggregates. An unweight formula (for example, Jevons or Dutot—see paragraphs 1.145–1.151 on elementary price indices) is usually used when aggregating the elementary aggregate price relatives of the sample of products at the elementary aggregate level. This practice is usually justified on the grounds that the required information such as market shares is simply not available to a sufficient level of precision. However, if broad-based estimates of market shares are available, then these can be used as implicit weights for determining the sample of price observations to enhance the accuracy of the elementary price index. Some possible sources for this information are transaction shares from scanner data, trade publications, market reports, and consultation with industry experts. The sample of price observations based on implicit weights can be updated independently and more frequently than the weights of the elementary aggregate; however, the price statistician will need to ensure that the weights are both coherent and consistent within the elementary aggregate. It is best to review them at the time of updating the basket.

Weights for Products for Which Prices Are Not Collected. As it is not feasible to collect a full set of prices from every outlet, including market stalls and street vendors, and from every provider of a service, all prices have to be sampled. This means that in practice there will be some products which consumers spend money on for which prices will not be collected. However, the expenditures for these products need to be included in the accounts definitions and classification systems for household consumption, which is an advantage when compiling a CPI as a macroeconomic indicator and for use as a deflator. National accounts have two inherent advantages: The household final consumption expenditure aggregate of national accounts may be derived mainly from the HBS, but national accountants will often use other sources of information before finalizing their results, especially in cases where the accuracy of the HBS is in doubt such as where underreporting is present. National accounts go through an additional

quality assurance process and re-estimation should increase the reliability of the weights. Even if the HBS is updated infrequently, CPI weights can still be updated at regular intervals from national accounts data for higher-level aggregates at the division or group level. However, there are two inherent disadvantages with national accounts data:

They are generally only available at the national level, so deconstruction of the national accounts data to provide a finer level of detail or to produce regional expenditure weights may be necessary using other available sources of information. Other data sources include HBSs, retail surveys, aggregated transaction from scanner data, and administrative data such as statistics on excise duty. National accounts data can be used to derive weights at the more aggregate level, and HBS data can then be applied to derive weights at the lower levels of the aggregation program. If the expenditure data from the HBS are not viewed as sufficiently detailed to ensure a minimum of acceptable accuracy, or if a demand exists for indices of a finer breakdown (for example, there is a need for a price index for apples but only expenditures for all fruit can be derived from the HBS), then other potential data sources can be used for disaggregating the expenditures, including surveys of retail sales from establishments, point-of-sales surveys and aggregated scanner data, surveys of production, export and import data, and administrative data. Note that some of these sources may also be used for stratifying expenditures according to sales volumes by retail outlet type and by region. National accountants apply an element of discretion and judgment when making operational decisions relating to the construction of national accounts. Some of the details of these decisions are not always readily available to users. Consequently, compilers of the CPI should consult with their national accounts counterparts regularly before using their data for weights in order to ensure that they are consistent with the objectives of the CPI.

3.0.18 Designing the Sample. Chapter 4 gives advice both on sample selection, that is, how to construct a sample, and on estimation procedures, that is, how to estimate the CPI from the sample "bread"). This approach will often lead to a more reliable elementary aggregate but may require an adjustment to the existing structure of the CPI. If annual HBS data are available, then expenditures could be averaged over more than one year thus improving the statistical reliability of the data, with regard to standard errors, but to the detriment of timeliness. It should also be noted that averaging may not improve the statistical quality of the expenditure estimates if a particular category of household expenditure is rapidly growing or declining. Averaging is useful if the particular expenditure category under consideration shows a lot of variability over several HBSs but no clear trend. This is an area where statisticians will have to use their judgment. The basket reference period should not be arbitrarily chosen and periods of less than a year should be avoided because of seasonal influences on consumption patterns. Furthermore, some countries exclude, from multiyear averages, years which are exceptional, for example, as a result of particularly poor harvests leading to high prices and distorted expenditure weights.

Leave the CPI structure unchanged and simply accept that the weight for the particular elementary aggregate concerned is less than ideal. Whether this is an acceptable position to take will depend on the weight of the elementary aggregate and on its importance, particularly to analysts. For example, it would be a difficult position to sustain if the elementary aggregate has a large weight and is presented as a published sub-index. It should be noted that in normal circumstances weights can tolerate a certain degree of imprecision before having a significant

effect on the overall CPI, particularly at the higher levels of aggregation, or main divisions of the CPI. But this is less so at lower levels. For instance, an index described as "fruits and vegetables" where the true weight for fruit is 40 percent and the weight of vegetables is 60 percent, but with a biased estimate of the expenditure weights, fruits account for 60 percent of the index and vegetables the remaining 40 percent. The biased weights affect the relative importance of both fruits and vegetables in the basket, giving too much weight to fruit and too little weight to vegetables. Consequently, the price index for "fruits and vegetables" will be also biased. To minimize the potential for such occurrences, it is recommended that the compiler always strives to get the best possible estimates for the expenditure weights. An annual HBS is optimal for a CPI because as well as avoiding one-off setup costs, it permits the annual updating of the weights, hence reducing the substitution bias associated with out-of-date weights in a fixed-basket index like the CPI. Furthermore, it provides the opportunity for using multiyear weights to reduce the sampling error and, where considered appropriate, minimize the sampling variance associated with unusual expenditure patterns in a particular year (for instance, abnormal circumstances affecting consumer behavior such as political events, natural disasters, or oil shocks). But obtaining reliable consumption estimates is challenging and there is a persistent trade-off between data quality and survey cost.

3.0.19 National Accounts. The use of national accounts weights ensures consistency and comparability between the CPI and national decided upon, such as regional indices or separate sub-indices for urban and rural areas. As well as cost, a limiting factor in sample design is the time taken in collecting prices. Practical considerations that will need to be considered include the availability of price collectors and transportation issues. In general, NSOs adopt four levels of sampling for local price collection: locations; outlets within locations; items within different sections of the expenditure classification; and product varieties. Stratification is also frequently used to increase sampling efficiency, especially where the retail market is heterogeneous. Often a combination of probability sampling and nonprobability sampling is used. When using probability sampling, the units in the sample are selected so that each has a known nonzero probability of selection. For instance, locations could be randomly selected from local administrative areas with probability according to total population, the population representing a proxy for the retail turnover in the area. Within a location, outlets could be randomly selected from a business register, with probability according to their individual turnover or sales or by floor area measured by an enumerator listing and visiting each shop. Sample selection based on probability according to size increases sampling efficiency. Also, as the aim is to have a sample which is representative of retail turnover, the prices subsequently collected on the previous basis would then not need to be rebalanced by reweighting if the assumption holds that those population and floor areas are good proxies for turnover. Alternatively, each location and outlet could be given an equal chance of selection in the sample, regardless of the total proportion of the retail market that they account for, but then reweighting would be necessary.

In practice, sample selection is never straightforward, and compromises must be made for good practical reasons even when a sampling frame exists. Administrative boundaries may not coincide well with statistical targets. For instance, choosing administrative areas using probability according to population could ignore the inconvenience of administrative boundaries that straddle the border between a commercial district and a residential area so that, contrary to the intention, the commercial district has no chance of being selected as it contains no houses.

Also, a visit to the location may indicate that it is impractical for the collection of prices, for example, because of a physical barrier such as a railway or river bisecting the area and causing difficulties of access. Similarly, very rarely do NSOs have readily available sampling frames which reliably list all retail outlets, particularly recent openings, and even fewer will have lists that cover all market stalls in all types of markets, or mobile street vendors. The relative advantages and disadvantages of random and purposive sampling should be examined at each stage of the sample selection. It is recommended that the NSO should first decide on the ideal sampling solution and then modify this to take into account practical constraints.

The ultimate goal should be: 1. ***An overall sample which is representative of the total population of goods and services being offered for sale*** of prices collected. This Manual recognizes that in practice nonprobability sampling sometimes needs to be carried out. Similarly, although the 2003 ILO Resolution states that probability sampling techniques are to be preferred, it goes on to say that "where appropriate sampling frames are lacking and it is too costly to obtain them, samples of outlets and products have to be obtained from non-probability methods" and that "statisticians should use available information and apply their best judgment to ensure that representative samples are selected." To construct a perfectly accurate CPI, the price statistician would need to record the price of every variety of every good and service purchased by the consumer. This would mean collecting a full set of prices from every outlet, including market stalls and street vendors, and from every provider of a service, including public utilities such as water and electricity, private transport including shared minibuses and the hire of rickshaws, modern forms of communication, such as mobile telephones, and the provision of domestic service. As this is not feasible in practice, most prices have to be sampled and this involves local price collection in a selection of outlets in a sample of locations chosen to be representative of the country as a whole and at selected times on selected days.

The exceptions to selecting a sample of prices as described in the previous one are prices which can be collected from a central source, such as a public utility provider, national retail chain headquarters, or a government department. For many of these items, all prices will be taken and no sampling will be involved. For example, the service provider may give the NSO a full price list or tariff from which all the prices can easily be extracted. This may be the case where sampling would not make sense or would be unreliable because the number of prices is very small. For instance, no sampling would be involved if an electricity tariff consisted of a standard standing charge for service provision and a standard charge per kilowatt of electricity used, which was the same for all customers regardless of location and only varied with total usage (with heavy users getting a discount after a certain threshold). In this case, the tariff prices would be collected and applied to a typical cross-section of users and varying quantities of electricity. Sampling would be used to choose a cross-section of users.

3.0.20 Approaches to Drawing Samples. The focus of this section is on sampling procedures for local price collection in outlets, including options relating to probability and nonprobability sampling. There is a section in Chapter 5 which specifically addresses the special challenges of sampling prices in markets and prices charged by street traders. Chapter 5 also addresses the associated issue of price bargaining and discusses the issue of volatile prices. As only a sample of prices will be recorded in the course of local price collection, there is inevitably some sampling error in measuring the CPI. The sampling procedures should aim to minimize this

sampling error, maximize precision for minimum fieldwork and processing costs) and reduce bias as much as possible. The sample design should allow publication of sub-indices at all levels which have been. Goods and services that normally are paid according to a tariff can pose problems when their structures are modified over time, compromising the principle of unchanged consumption. Examples include public transport fares, electricity, main water supply, physicians, hospital services, and telecommunications. For utilities, the payment may consist of a standard rate per unit of consumption sometimes in combination with a fixed charge. A solution to this problem is to define representative services or bundles of services (for example, categories of consumers and specific services consumed). For these, it is important that the prices experienced by a representative range of customers and tariffs are observed and that customer profiles are kept constant over time.

The focus in the next paragraphs is on locally collected prices. It begins by reviewing the principles behind collecting prices for a CPI and then considers the practical collection issues and how these should be managed. A working assumption has been made that the index being compiled is an acquisition index (see Chapter 4). It is also assumed that prices are being collected for a monthly price index with prices therefore being collected, in general, every month. Some countries produce only a quarterly CPI, while others produce a weekly index, especially for fresh food. The concepts and procedures discussed will apply to price collection practices, whatever the frequency of index publication.

***The Principles of Price Collection.** Except in a small number of cases, such as the treatment of owner-occupied housing costs, a CPI is usually designed to measure the change in the actual transaction prices of goods and services bought by consumers. However, collectors cannot normally observe individual transactions as they occur, so they must usually observe the price marked on or assigned to the product and assume that these are the transaction prices. Many countries are also improving the collection of actual transaction prices through the use of electronic technologies such as scanner data and internet purchases. An exception to observation and electronic capture is bargaining, where a price might not even be displayed, and Special procedures apply when outlets in which items are being priced close down, or the items which the price collector was pricing at a particular outlet are no longer sold by that outlet.

***The Principle of a Fixed Basket**. Underlying all of what follows in this section is an important principle: the necessity to compare prices on a like-to-like basis from one period to the next. This has two consequences: Where the price collector has the role of selecting what variety of a product to price in a particular outlet, a consideration should be whether that variety will be available to price over a reasonably long period (tight specifications are of no use if the described variety cannot be found in the outlets). This is in addition to being typical of what is sold to customers. *and purchased*. The sample chosen should be representative of price levels and, most particularly, price movements. All variations of items and outlet types should be considered for each product and chosen to reflect typical consumer purchasing habits.

****A variance or mean square error which is as low as possible***. Samples should be reasonably optimized. At the very least, a basic analysis of sampling variance should be conducted, even if an overall estimate of the precision of the CPI cannot be made.

Optimization. The entire set of sample prices should be optimized to meet the publication needs of the CPI, taking into account user requirements, practical data collection considerations, and cost.

***Collecting and Editing the Prices.** In large part, the considerations are the same as for sample design and will depend on local circumstance. For instance, the methods should consider: the purchasing habits of consumers and the extent to which they use licensed and unlicensed markets and internet purchases; the structure of the retail market including the balance between markets, small independent shops, and large retail chains; the extent of public ownership and price control; the diversity of goods and services being sold; the pricing structures used, including tariffs; and whether bargaining is common. The availability of central records of prices charged also has an important bearing. The 2003 ILO Resolution emphasizes the importance of well-trained price collectors who adhere to the standard procedures. There are two basic price collection methods:

Local price collection where prices are obtained from outlets located around the country. This will include licensed and unlicensed markets and street vendors as well as shops. Normally the price collector will need to visit the outlet to observe the prices although the prices for some items may be collected by other means, including telephone and price lists. ***Central price collection*** is often used where prices can be collected by the head office without the need for fieldwork. This may also include centrally regulated or centrally fixed prices which can be obtained from the regulatory authorities, although in these cases checks will need to be made to ensure that the goods and services in question are actually available and sold at the stated price. It is not unusual to find goods subject to price control being sold at a different "unofficial" price. Central price collection can be further broken down into: ***Prices which are combined with prices collected locally***. For instance, this may occur when a supermarket chain provides centrally determined price lists or actual transaction data, from scanners, eliminating the need for the price collector to visit a shop in person. ***Prices which are used on their own to compute centrally constructed indices***. Most tariffs fall into this category. The detection of errors in the collection and recording of price information must occur as soon as possible after the information is collected. Detection is usually achieved by examining price movements and checking those that exceed some predefined limits or appear to be unrealistic based on an analysis of all available information. Statistical outputs should sufficiently portray the reality of the economy, and with an output review, the compiler ensures the indices reflect reality. It should be noted that while price collectors should examine every price they collect, subjecting every collected price to the same level of examination by collection supervisors and index compilers is not considered necessary and generally is not feasible. It is recommended that, to improve cost-effectiveness, some form of significance rating should be applied to determine how much time and effort should be expended on editing individual prices.

In general, prices from elementary aggregates with relatively small price samples should receive more attention from the index compiler. This is because the weights of the elementary aggregates are broadly equal. Each individual price movement from these elementary aggregates will have potentially a much more significant influence on the index calculations than any individual price movement from an elementary aggregate with a large number of price quotes. Price samples from elementary aggregates with high expenditure weights should be examined critically as the

high expenditure weight will make all price movements within the sample significant to the index calculation. The highest risk is associated with elementary aggregates with relatively large weights but few price quotes and with complex index construction. This situation is associated with utilities and other services which account for relatively large expenditures and where there may be only one or a handful of suppliers and prices are based on complex tariffs. Petrol prices could be another example. There are two main categories of checking and identifying possible data errors and outliers. Non statistical checking. Statistical checking. The best results will therefore be obtained if conducted at the location where many prices are available to any analyst. This will generally be regional offices or, more probably, in the head office. However, the techniques can be adapted and still be applied to prices held by a small collection center as a way of quickly and efficiently detecting extreme prices. Abnormal prices such as sale prices, or price movements, such as sale recovery prices, may be excluded from automated procedures for the detection of outliers, in particular the setting of upper and lower bounds, but should nevertheless be checked, for instance by reference to previous price history. For seasonal items, such as fresh food and clothing, abnormal price movements will be normal. These price movements should not be excluded from the outlier detection procedures. It is important that an appropriate method. The price collector should record additional information needed to ensure the unique identification of the variety priced so that: The same variety continues to be priced in the case of price collection being carried out by a different person. The identification of quality change can be evaluated when the variety disappears and is replaced by a different one allowing an adjustment for quality change to be made.

3.0.21 Variety Specifications. There are no firm rules, especially regarding the use of looser or tighter variety specifications: each country may choose its preferred methods—and stick to them. However, there are a number of considerations in deciding on variety specifications:
Tight specifications leave less discretion to the price collector, so the reliability and training of collectors are factors to consider when deciding whether to use loose or tight specifications.
Particular care should be taken to ensure that the specification is very detailed for heterogeneous items where there is scope for significant difference between one variety and another, and for items which by nature are highly specified. Cars and hi-tech goods fall into the latter category. Tight specifications also allow for the calculation of meaningful average prices: Average prices are useful in identifying outliers and assessing the accuracy of the reported prices. Average prices allow comparisons of price levels, including between, for example, regions or urban and rural areas. Responsibility for specifying the items to be priced should normally rest with the head office. Specifications should be reviewed on a regular basis to determine whether they continue to be relevant. A revision of specifications could be implied by: (1) a large number of missing price quotations; (2) a large number of substitutions; or (3) a wide variation in the distribution of collected price levels. Some countries find structured product descriptions(SPDs) from the ICP helpful for specifying items to be priced in a CPI. As well as providing a ready-made framework for detailed item specifications the use of SPDs has the additional advantage of facilitating greater integration between the two price collection exercises leading, among other things, to savings in collection costs from using the same price quotes in both the CPI and ICP.

3.0.22 Data Editing. Once the price information has been collected and recorded it has to be edited. Data editing is the process of ensuring correct and usable data for calculation of price indices for elementary aggregates. Data editing is sometimes referred to as input editing. There

are three steps in this process: The detection of possible errors and outliers. The verification and correction of data

3.0.23 Output review detailed guidance both on implicit methods of quality adjustment, such as the overlap method and class mean imputation, and on explicit methods, including expert judgment, and the hedonic approach. Chapter 7 delves more deeply into the issue of item substitution, particularly on methods of incorporating new products into the index. **1.100** The 2003 ILO Resolution advises that when a product disappears "clear and precise rules should be developed for selecting the replacement product." It lists three selection strategies: the most similar; the most popular; and the most likely to be available in the future. On quality adjustment, this resolution states that "when a quality change is detected, an adjustment must be made to the price, so that the index reflects as near as possible the pure price change." It guards against the automatic assumption that "all price change is a reflection of the change in quality." It does not recommend particular explicit or implicit methods of quality adjustment but does state that "the methods used should as far as possible be based on objective criteria."

3.0.24 Missing Products. In order to measure price change from one period to the next, the price statistician tracks, for each elementary aggregate, the prices of a fixed sample of items. The detailed characteristics of the products, that is, the varieties of goods and services selected for pricing, are recorded to assist the price collector in fulfilling the aim of pricing exactly the same product in the same outlet in the same location so that the CPI compares "like-to-like" in subsequent periods. Also, the recording of detailed characteristics, especially price determining features, can help when needing to make adjustments to the recorded price due to changes in specification and hence quality. In practice, the particular product being priced in a specific outlet may become unavailable—for example, the product is discontinued, may be in temporary short supply, or may be a seasonal product which disappears when out of season. In all other cases, the price statisticians need to estimate the price of any missing product that they believe will return to the market within a reasonable time, or, if they believe it will not return, find a suitable replacement. If the price statisticians believe that the product will not return, the replacement should be either (1) as similar as possible to the previous one, or (2) the most popular "similar" product in the shop, or (3) the similar product that most likely will be available for future pricing. Unlike approach

(1) Which leaves the sample "static" with the risk that it will be increasingly out of date and difficult to collect prices for, approaches (2) and (3) have the advantage of introducing an element of sample replenishment. This is where quality adjustment becomes an issue. The price index should reflect only pure price changes—the price index should not reflect any portion of the price difference that is due to increases or decreases in quality between the missing item and its replacement. A value needs to be placed on any change in specification between the old and replacement item and a quality adjustment applied accordingly. This approach to quality adjustment applies to any replacement strategy, but is particularly relevant where sample replenishment takes place. is used to validate these prices.

3.0.25 Maintaining and Updating the Sample. One strategy to deal with the changing universe of products would be to resample, or reselect, at regular intervals the complete set of items to be priced. For example, with a monthly index, a new set of items could be selected each January.

Each set of items would be priced until the following January. Each January, both sets would be priced in order to establish a link between each set of 12 monthly changes. Resampling each year would be consistent with a strategy of updating the expenditure weights each year. For example, the Harmonized Index of Consumer Prices and many national CPIs in the European Union Member States resample items annually. Although resampling may be preferable to maintaining an unchanged sample or selection, it may not be practical for those countries that update weights infrequently. When the CPI is updated every five years, for example, systematically resampling the entire set of products each year would be difficult to manage and costly to implement. Moreover, it does not provide a complete solution to the problem of the changing universe of products, as it does not capture price changes that occur at the moment when new products or new varieties or models are first introduced. Many producers deliberately use the time when products are first marketed to make significant price changes. A more practical way in which to keep the sample up to date is to rotate it gradually by dropping certain items and introducing new ones. Items may be dropped for two reasons:

The product is believed by the price collector or head office to be no longer representative. It appears to account for a steadily diminishing share of the total expenditures within the basic categories in question. The product may simply disappear from the market altogether. For example, it may have become obsolete as a result of changing technology or unfashionable because of changing tastes, although it could disappear for other reasons. At the same time, new products or new qualities of existing products appear on the market. At some point, it becomes necessary to include them in the list of items priced. This raises the general question of the treatment of quality change and the treatment of new products.

3.0.26 Missing Products and Adjusting for Changes in Quality: A CPI should reflect the change in the cost of buying a fixed basket of goods and services of constant quality. In practice, this represents a challenge as products can permanently disappear or be replaced with new versions of a different quality or specification, and new products can also become available. has stayed in the same stratum. Similarly, a visit to the new location may indicate that it is impractical for the collection of prices, for example, because of a physical barrier such as a railway or river bisecting the area and causing difficulties of access.

***Products.** If a chosen product is temporarily missing and no price is recorded, a note to this effect should be made by the price collector. For a product temporarily missing, a price
has to be imputed. Non seasonal items and varieties should be replaced if missing more than a predefined period of time. For example, if it is out of stock for three consecutive months, then the collector should be instructed to choose a replacement which matches as closely as possible the product description unless it is decided to take the opportunity of a disappearing good to update the sample. Where a product is permanently unavailable for pricing, procedures need to be in place for determining a replacement and then impute a new base price if the replacement is of a different quality. Methods for imputing a missing price are discussed in the following text. As the issues relating to temporarily and permanently missing products differ—and their treatment is different—it is important for the price collector to establish whether the unavailability of a product is likely to be temporary or permanent.

A price may be considered as temporarily missing if the same product is likely to return to the market within a reasonable time period. This includes seasonal items for which special procedures apply. Permanent unavailability, on the other hand, occurs when a variety is withdrawn from the market with no prospect of returning in the same form. Products may be temporarily missing, for example, due to supply shortages caused by factors such as the seller underestimating demand, strikes by factory or transportation workers, or supply problems with imported products. In these cases, the price collector, although not able to observe a price in the current period, may have obtained information (for example, from the shopkeeper) to suggest that the same variety will become available again at some, perhaps unknown, time in the future. The previous discussion does not cover seasonal products, that is, where a product or item may disappear, because it is a seasonal product and it may be expected to reappear when it is next in season. The case of seasonal products is covered in detail in Chapter 11. Imputation procedures are fairly similar for both temporarily missing and seasonal products.

Temporarily (Nonseasonal) Missing Products. If it is believed that a missing product will be available again in a reasonable time, then the price statistician
has three options:

Omit the variety for which the price is missing so that a like-for-like comparison is maintained using matched pairs. The elementary index uses only those observations for which the price collector obtained prices of exactly the same variety in the current and previous periods. In
this approach, the price change for the deleted product, which was recorded up to the point immediately before its disappearance will be disregarded from that point on. Three situations that regularly occur are the following: Substitution procedures where an item, product, or outlet disappears, including the introduction of new items. The imputation of a price when a product is temporarily out of stock (excluding seasonal goods). Quality adjustment where a change of product involves changes in its price-determining characteristics. ***Substitution Procedures***. In a dynamic retailing environment, there is a continuous turnover both in outlets and in products.

Outlets. If an outlet goes out of business or refuses to participate in the price collection survey, it should be replaced with the same sort of outlet (for example, a market stall should be replaced with a market stall, or a single shop with a single shop) in the same location and conducting the same type of business (in other words selling the same types of goods). For example, if the previous shop was a butcher selling refrigerated meat, then another butcher selling refrigerated meat should replace it. If probability sampling was used to select the original outlet, the sampling frame should be revisited and a replacement outlet selected from the same stratum. Regardless of how the replacement is found, the original outlet's sampled items should be assigned to the replacement outlet for price observation. If an outlet changes location, a decision on whether the price collector should follow the outlet to its new location needs to consider both sampling and operational issues:

Sampling issues. The principle of maintaining a like-for like comparison holds. In practice, the balance of the sample needs to be maintained to ensure that it continues to be representative. Stratification is frequently used to increase sampling efficiency and ensure that the sample is representative. This means that when an outlet changes its location, reference needs to be made to the stratification and selection procedures used in the initial sample selection. For instance,

assume that shopping locations were initially selected from local administrative areas, stratified by an urban/rural split and outlet type, and then outlets randomly selected from those outlets within the chosen local administrative areas. Then the relocating outlet can be followed to its new location if it continues to fall in precisely the same stratum. However, if the outlet moves away from the original shopping location, for example, from an urban shopping district to a rural area outside the city or to another urban district within the city, or if it relocates within the same shopping location but becomes part of a multiple chain, then it has moved to another stratum and a suitable replacement for it should be found from within the original stratum, in order to maintain the sample balance.

Operational issues. As mentioned in Chapter 5 there may sometimes be operational reasons for departing from the sample generated by the standard selection procedures. For instance, efficient scheduling of price collection and the availability of price collectors may make following the outlet to its new location impractical, even though it different specification, normally two actions are required by the price statistician: Selecting a replacement product for pricing Quality adjusting the price if there are differences in quality between the outgoing product and its replacement. Each is considered in turn.

3.0.27 The Selection of a Replacement Product for Pricing. In practically every period for which a price index is compiled, some varieties of a product become permanently missing, not just in particular outlets but also because they are no longer produced or imported. If no action is taken, the sample of prices will diminish. Permanently missing varieties are problematic not just because of the potential impact on how representative the sample is, but also because it will lead to estimation of price change with samples that do not match from period to period; that is, the composition of the matched pairs changes. In addition, the index number for the latest month will be less reliable than that for the previous month because of the smaller sample size. The price statistician's task is to maintain the sample size by finding replacements for the specific varieties when they are no longer available and are not expected to return within a reasonable time. One of two alternative strategies can be adopted (replace with the most similar product and sample replenishment). Under both options it is important to identify any differences in quality between the original and replacement varieties as it is crucial to ascertain whether there is a quality difference, and, if there is, to estimate its value and calculate a quality-adjusted price.

Replace with the most similar product. This reduces the role of quality adjustment, as the more similar a product is, the less is the required quality adjustment (see paragraphs 1.118–1.131) but contributes to the deterioration in the representativeness of the sample where a product starts disappearing from the shops because it is being replaced by something new and sales are declining. Finding the replacement that is most similar to the original variety requires knowledge about characteristics of the previous variety. Good practice in price collection involves maintaining up-to-date descriptions of the variety's characteristics. The ICP developed SPDs for most item categories: these provide a framework to list the various characteristics—prioritized in order of their importance—of the varieties for each category.6 Such descriptions of characteristics can be used to match the characteristics between the old variety and various replacements so that critical characteristics are matched and less important characteristics can be noted. Critical characteristics are those that impact or contribute to determining the price, such as type of product (canned tuna fish), brand (StarKist), size (150 milliliter), and packaging (tin, in

water). Less important characteristics are those that do not affect the price, such as color of the label on the package or the location in the shop where the product is displayed. The salient considerations can be incorporated this may cause problems, for example, if it unbalances the sample.

Carry forward the last observed price. Carrying forward the last observed price is only recommended in the case of fixed or regulated prices. Although this provides price continuity in the periods when observations cannot be made, it is likely that short-term movements in the index are biased, since the sub-indices in question will show no change when prices are not available. If prices in general are rising, the bias will be downward, whereas if prices are falling, the bias will be upward. Carry forward is not recommended, particularly when there is high inflation or when period-to-period movements (as opposed to annual movements) in the price index are important. The carry forward method is appropriate only if there is reason to believe that the price has not changed. Typically, it will be difficult for the price statistician to validate the belief that the price has not changed, unless the price is fixed or regulated.

Imputation. The best solution by far is to impute a price. Imputation makes use of the best available information to provide an unbiased estimate of price movement**.** There are essentially two choices This assumes that the price change of the missing product, if it had been available in the shop, would have been equal to the average change in prices in the elementary aggregate. This may be a reasonable assumption if the elementary aggregate is fairly homogeneous. This method of imputation is equivalent to the "omit" method (see first bullet point), no matter whether a Jevons, Carli, or Dutot method of aggregation is used at the elementary aggregate level. In a given month this approach provides similar results to the "omit" method described in the first bullet previously; however, across time, the two approaches will not produce the same results if the index is compiled using the short-term formulation. This is because the imputed prices are used to compile the index from month to month. ***Impute the missing price by reference to the average price change for the prices of "comparable" varieties from another similar outlet (class mean imputation)*.** This represents a more precise match between the missing product and the products supplying an imputed price. It is normally preferable to impute using the average price change in the elementary aggregate unless the imputations are unreliable because of small sample sizes.

Permanently Missing Products. When the situation arises where a product permanently disappears or is replaced by a new version with a collector should determine if the outlet is likely to continue selling the replacement. If it is also expected to be discontinued in the near future, then a different variety should be selected — either another that is similar to the first, or the most popular variety within the product line. As will be seen, there are several different methods for both the explicit and the implicit types of quality adjustment, but there are some common themes in the methods of each of these two main types. Explicit methods estimate the impact on price of changes in characteristics or features of the product. Implicit methods estimate the impact on price indirectly by reference to price differences between different varieties. ****Comparable Replacements***. If the selected replacement product is regarded as comparable, then the observed price change is treated as a pure price change. But the price statistician should gather and examine all the available evidence, if possible taking advice from market experts where necessary, before coming to such a conclusion. Even in cases where a replacement product is

believed to be of comparable quality, care should be taken, since experience suggests that most goods tend to undergo steady improvements, especially hi-tech and electrical goods.

Direct or Explicit Quality-Adjustment Methods. There are a number of direct or explicit methods for determining the price associated with a change in quality. But quality adjustment is not an exact science, and different evaluations can yield different results. The point is that even if the evaluation methods used are somewhat imprecise in the measurement of the quality difference, it is important to make an adjustment. If quality differences are not removed, the price index will reflect the quality change in addition to pure price change and is likely to have an upward bias because quality usually increases. The most common ways of making an explicit quality adjustment in practice are as follows: ***Package size adjustment***. The value of a change in package size is assumed to be proportional to the relative change in the package size.

Expert judgment. The price collector determines the value either through direct knowledge or in consultation with personnel in the shop where the product is sold. Alternatively, NSO staff, who may be knowledgeable about the product, can estimate a value. Reliance on an individual's knowledge concerning the products depends, however, on the individual obtaining sufficient market information and is also liable to subjectivity. The judgment needs to be properly informed. ***Reference to the producer cost***. The production cost from the producer can be used in the case of an improvement to an existing product, although a judgment then needs to be made on whether to apply an adjustment factor. For example, the adjustment might consist of the normal retail markup to reflect wholesalers' and retailers' costs and profits. In the context of a COLI, a downward adjustment may be appropriate to account for the fact that the new "standard" feature will not increase the utility to all into a decision-making framework for identifying a similar product, as follows: There is a basic match of the main characteristics, particularly those which determine price. Consumers perceive them as similar even though some characteristics may be different. This may be the variety in the shop that buyers are most likely to buy in place of the original. They are used for the same purpose and in similar situations. For food this may include a consideration of whether the brand is one for everyday consumption or only for special occasions. Under the "replace with a similar product" strategy, an updated version of a product (that is, the one that the supplier lists as the replacement), is the logical starting point for the replacement for its predecessor. In most instances this would be the one that is the most similar to the original variety, so the price statistician can compare "like-to almost-like." In instances where the most similar variety is also one that is likely to soon disappear, the price collector should select the variety that is most popular within the outlet for the product class. Although this strategy is less likely to yield a replacement that is sufficiently similar to permit direct price comparison, it will reduce the likelihood of the replacement disappearing in the near future and will keep the need for quality adjustment to a minimum.

Sample replenishment—replace the missing product or variety with the currently most representative one by going through a process of resampling. The extent to which a sample remains representative is highly dependent on the rules used for item replenishment when a particular variety or product disappears from the shelf of a particular outlet. Compared with the option of replacement with the most similar product, sample replenishment has the benefit of maintaining the current representativeness of the sample. If disappearing products are always replaced with similar products, the sample will gradually become less relevant to market reality.

Sample replenishment also increases the chances of the replacement being available on the shop shelf for pricing. The problem of a deteriorating sample increases with the rate of turnover in varieties and products and with the rate of product development.

3.0.28 Adjusting the Price for Differences in Quality. When a product disappears or is replaced with a new version of a different quality or specification, then one of the following methods of introducing the price of the replacement is adopted: i). Comparable replacement ii.) Direct (explicit) quality adjustment iii.) Implicit quality adjustment (imputation). In all cases, a nominal price in the base month is needed for the new or replacement product—this nominal base price is used until the next rebasing. The price collector should record the specifications (the price-determining characteristics) of the new variety so that the head office can determine if the replacement is of similar quality to the original variety. The price observed price for the "old" item. This will yield an estimate of what the replacement item would have cost in the previous period. Assume that the NSO was able to determine that, based on the differences in characteristics, the value of the quality difference between Brand C and Replacement 1 was $25 in period 1. The price statistician can add this amount to the price of Brand C in period 1 to obtain an adjusted price.

***Implicit Quality Adjustment**. If the replacement product is of a different quality or specification and no information is available to quantify the difference, then assumptions have to be made about what proportion of the price difference is accounted for by differences in quality. Implicit quality adjustment creates an imputed "quality-adjusted" price based on price changes from similar varieties of the product. The precise nature of the imputation depends on the index formula that is used. A basic assumption underlying the most commonly used implicit quality-adjustment methods is that the difference in quality between varieties simultaneously available in the market is equal to the difference in price between the varieties or models.9 Thus, when a product disappears from the shelf, an underlying assumption is made when imputing a price that a price differential continues to reflect a difference in quality. Most countries construct some form of a fixed base price index. If price movements are estimated using long-term price relatives from the base period, then the base price may be adjusted proportionately for the estimated quality difference. If price movements are estimated using short-term relatives from the previous period, then an imputation adjustment can be implicitly made by estimating
the missing variety's price in the current month from the average price change in its elementary aggregate. The price change of the omitted observation is equal to the change in
its elementary aggregate.

***Overlap Pricing.** This method requires knowledge of the prices of the two varieties in the same time period—the overlap period. If the old and new varieties are available at the same time because the price collector either knows in advance that the old variety will disappear soon and selects and prices a replacement, or the outlet is able to accurately give the price of the replacement in a previous period when the old variety was priced, then the price difference between the two is taken to be the value of the quality difference. The rationale is that it cannot be due to price change because price change occurs only over time. The price index uses the old variety in the overlap period and the new variety in the next period and the price differential between the old and new varieties. purchasers, for example, some may not welcome air conditioning in a car because of the extra running costs. Compilers of the producer price index

often attempt to gather information on production costs from manufacturers for quality-adjustment purposes. However, producers may be unwilling to provide information on their marginal costs for reasons of confidentiality. There are a number of potential problems with using the producer cost method. In particular, it is not necessarily the case that the cost of production, with an adjustment factor along the lines described previously, gives a good indication of the selling price.

The former "option" price. In the case where an optional feature has become standard, the former price charged for the optional feature can be used as the explicit quality-adjustment value but again, consideration will need to be given to whether a scaling-down factor should be applied—in this case possibly a downward adjustment to reflect the reduced production costs of making a feature "standard" and also, in the cost of living context, that the utility gain is less than the increase in price. Some of the concerns relating to using producers' costs (see the previous bullet point) apply, the main difficulty being that it is likely that the market valuation of the options will have changed once they become standard, indeed, it is often because of changing market circumstances that producers make former options standard.

Hedonic regression. Another way to obtain a value of the quality difference is to use hedonic regression to estimate the value of changes in a product's characteristics. Hedonic methods require large databases with a wide range of product characteristics. Such databases are seldom available in NSOs (though for some products scanner data from large stores may be a viable source in some countries) and can involve substantial development and maintenance costs. In addition, hedonic models need to be re-estimated periodically. Hedonic methods should be applied only where they add significantly to the statistical integrity of the index. This is most likely to be the case with hi-tech high turnover goods. In explicit methods, the monetary value of the quality difference is determined directly using one of the previous methods and then applied to a previous period's comparable with explicit quality adjustments, but the remaining ones will need imputed prices. Class mean imputation calculates imputed price relatives using only the prices of comparable and, where appropriate, explicitly quality adjusted varieties or models. In general, it does not use the prices for the varieties or models that were not replaced, because these are likely to be different from those of new models. The prices of old models tend to fall as they become obsolete, while the new models (represented by the replacements) tend to have a higher price before falling. This may not be relevant in developing countries where new products appear in the retail market relatively late at a "mature" price. Using class mean imputation adds complexity but reduces two types of bias referred to earlier: bias from ignoring quality change altogether and treating all price movements as price change, and bias from over adjusting for quality change by treating some pure price change as quality change.

***New Products.** An entirely new product, in contrast to a new variety of an existing product, is essentially a replacement of a previously popular product and represents a good or service that: Was not included and could not be included in the price index during the initial selection of the current market basket and which is now available for possible inclusion in the index Cannot be easily linked to the service flow or production technology of existing goods and services; that is, it represents a distinct departure from previously available products insofar as it is a step change with regard to technology or utility to the consumer Has a recognizable and generally accepted new benefit to consumers as a result of becoming available. The last two cases help to

distinguish an entirely new product—referred to as a *revolutionary* product—from an existing product whose features and, in consequence, "quality" has changed—an *evolutionary* product. A revolutionary product is an entirely new good or service that is not closely tied to a previously available product. A revolutionary product tends to be a good or service that is expected to satisfy some need in a new way and is unlikely to fit neatly into an existing CPI item category. As an example, when mobile telephones were first introduced, they provided a significantly new service. While on the one hand, they provided an extension of an existing flow of service (telecommunication), on the other hand, they provided a dimension of service that was new (the opportunity to make "mobile" calls away from a fixed telephone) and a distinct product from existing landline telephone services (it was a step change in technology). It is therefore an example of a revolutionary product. More recent examples of revolutionary products are broadcasting (streaming) services for television and smartphones, downloads of games, and electronic storage of data (the "cloud"). Examples of evolutionary products would never affects the index. In this case, the market has determined the value of the quality adjustment.

***Overall Mean Imputation.** Overall mean or non-class mean imputation (also referred to as "linking," "splicing," or bridge overlap method in the context of the European Union's Harmonized Index of Consumer Prices) imputes an overlap price for the old variety in the current period by reference to the price changes between the previous and current periods of similar varieties or items. The latter are used to impute a price change for the old variety, which can then be used to obtain the imputed price. The ratio of the imputed price for the old variety and the price of the new variety in the current period is the estimated quality adjustment. An estimate of the price of the missing variety can still be made even though the price of the replacement variety may not be known for the previous pricing period using the overall mean price change for the elementary aggregate. The overall mean procedure assumes that the pure price change from the replaced item to the replacement item is the same as that for the composite of all other goods in the same group. It is used frequently because of its simplicity, but there can be an inherent bias built into the methodology, particularly when major model changes are occurring.

The direction and extent of this bias is a matter for debate but depends on whether the actual quality adjusted change in price is bigger or smaller than the measured price changes of the items used in the imputation. Major price changes can frequently occur at the time new varieties or models of a product are introduced. This is quite common, for example, with new vehicles, household appliances, electronic equipment, and clothing items. As the new varieties are introduced there may still be a substantial supply of the old varieties which are showing little price change or may actually be declining in price. In consequence, using the old varieties' price changes to impute the price changes for new ones will underestimate the actual price change for the new varieties and cause a downward bias in the price index. The use of the overall mean imputation procedure, in which all observations in the elementary aggregate are used, is not recommended for such cases. It is also possible, and can be argued (but less convincingly), that the use of the overall mean leads to an upward bias because the price changes associated with models that are unchanged in quality will be further along the evolutionary cycle and therefore will be rising less rapidly. An alternative imputation procedure, called "class mean" imputation, avoids some of the problems associated with bias.

***Class Mean Imputation.** Class mean imputation is similar in procedure to the overall mean imputation, but uses only the price changes of "comparable" replacements to impute the overlap price, the replacements being limited to those that have exactly the same price-determining characteristics, or those items with replacements that have been declared comparable after review or have already been quality-adjusted through one of the "explicit" methods. For example, when the arrival of a new model of a particular brand of motor vehicle forces price collectors to find replacements, some of the replacements will be of comparable quality, others can be made the sample, as manufacturers usually introduce more up-to date features into new models. However, the representativeness of the new model, as measured by its popularity, will only be determined over time. Further discussion of the methods for introducing into the CPI basket replacements for products which no longer exist and disappear from the shop shelves is presented:

As a *supplement to the sample by adding a new variety or making a targeted replacement to drop an old variety and add a new one. This represents a more proactive approach to product substitution. Again, it is normally associated with evolutionary products. The CPI collection Procedures instruct price collectors to replace the old, less popular variety of canned tuna fish in oil, with the new, more frequently bought tuna packed in water even though the former remains available. This is different from the standard reactive approach of replacing the old disappearing variety with the new one because the old variety still exists and may not be discontinued although may be increasingly difficult to find (and less popular/ lower turnover shares). The new variety is supplementary to the old variety and begins to gain market share while the old variety declines in market share. This more proactive approach requires the price statistician to monitor the market for the entry of new varieties and to get a sense of their popularity with consumers, for example, by noticing the changing proportions of shelf space occupied by the different varieties or by talking to the shopkeeper. The head office can also help by gathering sales information from other sources.

As a *planned introduction of a revolutionary product which consumers begin to buy so that the product has an increasing share of the market. The appearance of revolutionary products in the marketplace and consumer reaction to them, as measured by sales, are less predictable than for evolutionary products. Revolutionary products also tend to have different price trends from other products in the sample and can therefore exert an influence on the CPI disproportionate to actual sales. For these reasons, revolutionary products are important, represent a significant challenge, and warrant special attention, requiring the price statistician to be particularly attentive and proactive. The previous circumstances can be managed either in a planned way, as part of a regular process of updating the CPI basket, including chain linking or in an ad hoc way when the need arises, or the circumstances warrant action to be taken.

3.0.29 Timing of the Introduction of New Products. The timing of introduction of new products can vary by the type of product and may be dictated by the method of incorporation into the index. For revolutionary products, it can be particularly critical to the accuracy of the index as there is a greater potential for introducing bias if these products are ignored. This is less likely to be the case for evolutionary goods. Already new models of household appliances such as refrigerators and washing machines where improvements in quality are introduced from time to time. Evolutionary products can also be newly added brands of currently available products such as a new type of canned fish or electronic appliance which differs from those currently available.

For example, a current brand of canned fish may consist of certain types of fish (mackerel, salmon, or tuna) and then a new variety for one of the canned fish is introduced which is packed in water rather than oil. The focus is on keeping the basket of goods and services that are priced up to date and relevant. It covers both truly and completely new products, that is, those which are *revolutionary,* as well as those which are *evolutionary* and also goods or services previously provided free and thus previously excluded from the CPI. It does not deal directly with substitution and quality change when a good or service unexpectedly disappears.

***Planning for the Introduction of New Products.** There are three sets of circumstances in which new goods and services are included in the CPI:

****As "replacements" for products which no longer exist***. This is normally associated with evolutionary products. Producers often discontinue old versions of their products and introduce new versions that are quite similar but may be of a different quality at a different price. Note that "quality change" includes changes in technical specifications as well as more clearly visible outward changes in design. This can happen frequently and is usually unplanned for in a CPI, although not necessarily unexpected. It is often associated with forced replacements when collectors go to price a product only to find that it is no longer sold. In the CPI, collection procedures usually instruct price collectors to replace the old versions (models)
with: ***The most similar model***. For example, when the old model of washing machine is discontinued, the price collector is instructed to replace it with another model which has similar (though probably not identical) specifications and to record any changes in characteristics (specifications) to aid the evaluation of potential quality differences.

Alternatively, replacements can be products that are currently the *most popular* with consumers. This represents a deliberate attempt to refresh the CPI basket when a replacement has to be made. For example, the current varieties of canned fish may include tuna. Producers may have introduced a new variety that contains tuna packed in water rather than oil, and consumers are now shifting their buying patterns to purchase more of the new variety. There is no external factor forcing the consumer to change to the new product. In some instances, when a model ceases to be produced, the manufacturer will indicate which model is the replacement and the CPI collection procedures instruct the price collector to start collecting the price of this replacement. This also normally contributes to the replenishment which does not include the new product class is still being used. Because it is not known exactly which other expenditures are being reduced relatively as the new product is purchased, this rescaling of weights is somewhat arbitrary and may lead
to credibility issues.

***Calculating the Consumer Price Index.** The calculation of CPIs usually proceeds in two stages. First, price indices are estimated for the elementary expenditure aggregates, or simply elementary aggregates. Then these elementary price indices are averaged to obtain higher-level indices using the relative expenditure values of the elementary aggregates as weights.
Elementary Price Indices. The weights used in the CPI are generally derived from the HBS at levels that are typically for an item grouping such as cheese, butter, or milk. There is no identification of the specific variety of the product and an associated weight. NSOs select a sample of individual varieties to represent each item, but there are often no weights available at

the variety level. The NSOs then use some method of averaging to produce an average price or an average price change to use in deriving the item or elementary index. This level of computation is usually referred to as an elementary aggregate because it is the first level at which an index is compiled for aggregation to higher levels of the CPI. When weights are not available, the choice of the averaging method can be very important. Chapter 6 of *Consumer Price Index Theory* shows that the larger the variation in the individual prices, the larger the difference among the standard averaging methods. Both arithmetic and geometric averaging can be used, but geometric average formulas are recommended.

Arithmetic Average. The two methods used historically by NSOs to calculate the elementary indices are the ratio of average prices, known as the Dutot index, or the average of price relatives, known as the Carli index. Each of these formulas can be calculated using either the long-term price relative formula (comparing current to base period prices) or the short-term price relative formula (comparing current to previous period prices). The short-term versions of these formulas calculate a long-term relative change by chaining together the short term price relatives. It should be noted that the chained Carli produces different results than those for the fixed-base Carli using the average of long-term price relatives. The chained Carli price index has a definite upward bias. This chained version of the Carli index should not be used by NSOs for calculating elementary-level indices in the CPI.

Geometric Averages. With the introduction of the *CPI Manual* in 2004, a major emphasis was placed on using geometric averaging mentioned in the previous paragraphs—replacing with the most similar product or replacing the missing item or variety with the currently most representative one. The strategy of replacement with the most popular is more likely to maintain the relevance of the sample by going through a process of resampling and identifying an appropriate replacement product. In order to make a properly judged decision on which strategy to follow and to inform the choice of replacement product and timing of introduction, the NSO needs to be aware of current consumer market trends, including what new products are becoming popular and what supplementary products are being introduced. It also needs to monitor product turnover, which can be an indication of the rate of product development associated with evolutionary products, and can vary between different categories of products. This information can be obtained from data gathered by price collectors and their supervisors, commodity experts in the NSO (for instance, working on the CPI or the producer price index) or from trade journals, products identified through scanner data, and consumer reports.

*** Evolutionary products** should be included in the sample as soon as it is clear that consumers are shifting to these new products from the old versions. A frequent updating of the basket reduces the need for the ad hoc introduction of evolutionary products. **Revolutionary products** usually first appear in the marketplace at a high initial price to cover development costs and to exploit the novelty value to the consumer. The prices generally start to decline as they become more established and competing varieties enter the market resulting in increased supply. The timing of introduction into the CPI basket is a critical issue—if introduced too late it will not only reduce the representativity of the CPI basket but could also give too much weight to any price decline associated with obsolescence of the product it is replacing when it nears the end of its life cycle but is still in the CPI basket. For revolutionary products the timing of their introduction into the CPI is important. In practice, often they are not introduced until they can be

included in a new basket at the time of a CPI revision. This can lead to out-of-date and unrepresentative baskets if the revisions are carried out infrequently or with a long time lag, for instance as a result of delays in processing HBS data. But the price statistician is also confronted with uncertainty; it is not always clear how the retail market will react in the longer term to the introduction of a revolutionary product—some will be highly successful, achieving significant sales volumes and market stability in a relatively short time, while others may achieve high sales at an early stage which are not maintained.

Methods of introduction which overcome the problem of lack of timeliness include sample supplementation, targeted replacement procedures, and reinitiating (or rotating) the sample for the elementary aggregate or COICOP class. These methods are discussed in detail in Chapter 7 and, sample re-initiation apart, are generally applicable to evolutionary products. For revolutionary products, a new elementary aggregate must often be created. Frequent updating of the CPI basket reduces the potential problems and the introduction of revolutionary new products at the time of a basket update has a number of operational advantages: namely, the old weights do not need to be rescaled if a new product class is introduced when an old basket which make a rational choice between the various possibilities means having a clear idea of the target index that would be preferred in principle. The target index can influence practical matters such as whether the weights used in the index should be price updated. Most of the standard indices used to compile CPIs (Laspeyres, Lowe, and Young) have known biases. The next paragraphs include summaries of the different formulas that can be used. Chapter 8 provides more details on these formulas that can be used to calculate the CPI.

Price Indices Based on Baskets of Goods and Services. The purpose of an index number may be explained as comparing the values of households' expenditures on consumer goods and services in two time periods. Knowing that expenditures have increased by 5 percent is not very informative if one does not know how much of this change is attributable to changes in the prices of the goods and services, and how much to changes in the quantities purchased. The purpose of an index number is to decompose proportionate or percentage changes in value aggregates into their overall components of price and quantity change. A CPI is intended to measure the price component of the change in households' consumption expenditures. One way to do this is to measure the change in the value of an aggregate, holding the quantities constant.

***Lowe Indices.** One very wide, and popular, class of price indices is obtained by defining the index as the relative change, between the periods compared, in the total cost of purchasing a given set of quantities, generally described as a "basket." The meaning of such an index is easy to grasp and to explain to users. This class of index is called a Lowe index, after the index number pioneer who first proposed it in 1823 (see Chapter 2 of *Consumer Price Index Theory*). Most NSOs make use of some kind of Lowe index in practice. The Lowe index formula can be found in Appendix 6 and is described in more detail in Chapter 8. Lowe indices are widely used for CPI purposes. In principle, any set of quantities could serve as the basket. The basket does not have to be restricted to the quantities purchased in one or other of the two periods compared, or indeed any actual period of time. The quantities could, for example, be arithmetic or geometric averages of the quantities in the two periods. For practical reasons, the basket of quantities used for CPI purposes usually has to be based on a survey of household consumption expenditures conducted in an earlier period than either of the two periods whose prices are

compared. For example, a monthly CPI may run from January 2018 onward, with January 2018= 100, but the quantities may be derived from an annual expenditure survey made in 2015 or 2016, or even spanning both years. As it takes a long time to collect and process expenditure data, there is usually a considerable time lag before such data can be introduced into the calculation of CPIs. The basket may also refer to a year, whereas the index may be compiled monthly or quarterly. When weights are not available for the individual prices in the CPI elementary indices. The geometric price index is known as the Jevons price index and is calculated either as the ratio of the geometric average prices or as the geometric average of the price relatives.

The Jevons index generally provides different estimates than both the Dutot or the Carli. Whether using the long-term price relative method or the short-term relative method Jevons indices yield the same index numbers as shown in Chapter 8. The same property holds true for the long-term and short-term Dutot indices. This property does not hold true for the Carli index. The chained short-term Carli index is always equal to or greater than the long-term Carli index. Chapter 6 strongly encourages the use of the Jevons price index for calculating elementary indices where weights are unavailable. It notes that the Dutot price index should only be used in cases where the sample of transactions is homogeneous with respect to base price levels or price trends. It strongly discourages the use of the short-term Carli price index because of its known upward bias. The short-term method for the Jevons index will easily accommodate replacement varieties or adjustments for quality changes. As mentioned earlier, the NSO will only need to collect prices for the current and previous periods to enter in the system. If the long-term method is used, quality adjustments will involve changing the base price of the transaction for the value of the quality change.

Choice of Higher-Level Index Number Formula. The NSO has to decide on the kind of index number to use. The extensive references dealing with index theory in the bibliography of this Manual reflect the fact that there is a very large literature on this subject. Many kinds of mathematical formulas have been proposed over the past two centuries. While there may be no single formula that would be preferred in all circumstances, most economists and compilers of CPIs seem to agree that, in principle, the index formula should belong to a small class of indices called superlative indices. A superlative index may be expected to provide an approximation to a COLI. A characteristic feature of a superlative index is that it treats the prices and quantities in both periods being compared symmetrically. Different superlative indices tend to have similar properties, yield similar results, and behave in very similar ways. Because of their properties of symmetry, a superlative index is also likely to be seen as desirable even when the CPI is not meant to be a COLI. When a monthly or quarterly CPI is first published, however, it is invariably the case that there is not sufficient information on the quantities and expenditures in the current period to make it possible to calculate a symmetric, or superlative, index. In cases where the prices and quantities are available, care must be taken to use index methods that do not result in biased estimates (for example, chain drift). of *Consumer Price Index Theory*. While it is necessary to resort to second-best alternatives in practice, being able to for different approaches for the modified versions of the Lowe and Young indices.

3.0.30 Geometric Young, Laspeyres, and Paasche Indices In the geometric version of the Young index, a weighted geometric average is taken of the elementary aggregate price relatives using the expenditure shares of period *b* as weights. The geometric Laspeyres is the special case

in which $b = 0$; that is, the expenditure shares are those of the price reference period 0. Similarly, the geometric Paasche uses the expenditure shares of period *t*. It should be noted that these geometric indices cannot be expressed as the ratios of value aggregates in which the quantities are fixed. They are not basket indices, and there are no counterpart Lowe indices. The geometric Young and Laspeyres indices have the same information requirements as their arithmetic counterparts. They can be produced on a timely basis. Thus, these geometric indices must be treated as serious practical possibilities for purposes of CPI calculations. The geometric indices are less likely to be subject to different types of index number biases than their arithmetic counterparts. Their main disadvantage may be that, because they are not fixed-basket indices, they are not so easy to explain or justify to users.

***Symmetric Indices.** The standard price index methods used in most countries today, that is, the Lowe and Young indices, date back 90 years to those proposed by W. C. Mitchell (1927) and G. H. Knibbs (1924). Index number theory has advanced substantially, particularly in the past 30 years, to provide better information on what the target index number formula should be. Various approaches have been used to evaluate index number formulas and derive those best suited for inflation measures. The research presented in *Consumer Price Index Theory* has resulted in improvements for fixed basket formulas and identified target indices that are symmetric averages of standard formulas. The target indices are the Fisher, Törnqvist, and Walsh price indices, discussed in detail in Chapter 8. However, these usually cannot be produced in final form except with a lag because they require both current and past weight information. Thus, most NSOs use the fixed-basket indices where the weight data are derived from some past period. An exception can occur in countries where scanner data are available and symmetric indices can be produced in real time. A symmetric index is one that makes equal use of the prices and quantities in both the periods compared and treats them in a symmetric manner. There are three symmetric indices that are widely used in economic statistics; these three indices are also superlative indices, the Fisher, Walsh, and Törnqvist.

Different formulas are used at different stages of aggregation. At the elementary or first stage, where prices are first combined to form an index, many countries will not use weights. At the second and higher levels, weights are applied, but these weights generally relate to some period in the past that becomes less representative with the passage of The index can be written, and calculated, in two ways: either as the ratio of two value aggregates, or as an arithmetic weighted average of the price ratios, or *price relatives*, $pit / pi0$ (where *pit* refers to the price of the item in the current period and $pi\ 0$ refers to the price of the item in the reference period) for the individual products using the hybrid expenditure shares $si\ 0b$ as weights. The expenditures are described as hybrid because the prices and quantities belong to two different time periods, 0 and *b*, respectively. The hybrid weight may be obtained by updating the actual expenditure shares in period *b*, namely, $pibqib / \Sigma\ pibqib$, for the price changes occurring between periods *b* and 0 by multiplying them by the relative prices, $pi\ 0 / pib$.

***Laspeyres and Paasche Indices.** Any set of quantities could be used in a Lowe index, but there are two special cases which figure very prominently in the literature and are of considerable importance from a theoretical point of view. When the quantities are those of the price reference period, the Laspeyres index is obtained. When quantities are those of the other period, the Paasche index is obtained. **Young Index.** Instead of holding constant the quantities of period *b*,

an NSO may calculate a CPI as an arithmetic weighted average of the individual price relatives, holding constant the expenditure shares of period *b*. The resulting index is called a *Young* index, again after another index number pioneer. Whether to price update or not, and the resulting choice of index. **Short-Term Price Index Formulas.** Many countries use a modified version of the Lowe or Young index that compiles the index based on short-term price changes rather than the long-term price changes. This modified method can be compiled in two ways. Using the first approach, index compilation involves a two-step estimation process that breaks down the price movements into short-term, period-to-period changes that are used to bring forward the index from the previous period. In the second approach, elementary-level indices are compiled based on chained short-term price changes and the calculation of upper-level indices uses the base period weights. There is no preference as to which approach is preferred. Countries can decide which approach should be applied. The use of the short-term formula makes it easier for NSOs to introduce replacement items in the sample if the ones they have been tracking are no longer available. The short-term approach also enables the NSOs to make quality adjustments as improvement (or deterioration) is made to the sampled varieties. The NSO only needs to collect the current and previous prices for the item in order to introduce it into the index. In using the long-term method, the base price will need to be adjusted for the changes in the quality of the items in the sample.

For infrequently updated CPIs, a single year is preferred as the price reference period. Where a single month (or quarter) is used, the prices of some seasonal products will be unavailable or unusually high or low and many unusual or imputed prices may have to be used for the price reference period. For countries with infrequent weight updates, it is preferable that the price reference period is a whole year in which seasonal prices would be appropriately represented. In some months there will be no sales of, for example, seasonal fruit, but an average price for the whole year would still be available for the price reference period. The index reference period should be one year. Using a single month or quarter to serve as the index reference period (= 100), can result in distorted index changes because of the unusual or imputed prices in that period. Chained CPIs weights are updated on an annual basis. Because annual updating allows for a relatively small lag between the weight and price reference periods, a single month is used as the price reference period. There is a continuing flow of price data that may include imputations, and a relatively small number of changes in specifications or products; the major exercise is to introduce the new weights into the flow of price data and link this to the existing chain.

For infrequently rebased CPIs, the use of a single month as the price reference period is not advised; however, it is often the case that the country's resources only allow for a price reference period of less than a full year. NSOs should strive to maximize the number of months used as the price reference period, with the goal of using a full year. A primary shortcoming of using a short reference period for infrequently rebased CPIs is that out-of-season items in the price reference period will have no observed or economically meaningful price. The decision as to which month to use for the price reference month should consider when seasonal items with relatively high weights are in season. If these items are not in season, an imputed price will have to be used and consideration should be given to the validity of imputation methods for out-of-season items in this context. For example, if the carry forward method (which is discouraged) is used and the reference month uses an imputed price for the out-of-season item, the index may be unduly low.

As mentioned previously, the two-stage Laspeyres aggregation is preferred since it avoids the need for long-term price comparisons with this one-month price reference period. A primary shortcoming of using a longer price reference period are the resources needed to collect a full year of prices for all items included in the CPI basket. Some countries struggle with the resources to collect prices for two baskets (old and new) simultaneously. To minimize the burden, some countries have begun looking at preliminary expenditure data on a quarterly basis during the HBS collection period and to identify any new items that may be introduced into the basket. Once new products have been identified, prices can be collected.

3.0.31 Linking Previous Consumer Price Index to the New Price Index Reference Period.
The NSO may choose to start the new series using the new price reference period as the new index reference period. In Chapter 9 the recommendation is that when new time. When compared to the target indices (Fisher, Walsh, or Törnqvist), it becomes apparent that the indices produced in practice are of substantially lower quality than the target indices. This Manual discusses these issues thoroughly and provides approaches that countries can implement over time to move closer to the target measures.

***Updating the Weights and Linking of Series.** Note that over time the CPI weights and basket become less representative of the consumer market. The weights and basket should be updated at least once every five years to maintain their relevance. Many countries strive to conduct an HBS on a five-year cycle to use for updating the CPI basket and provide detailed information on household expenditures for use in the national accounts. From the HBS consumption estimates, NSOs will identify the most important items to use in the new CPI basket. Deriving the new basket involves adding items that have gained importance since the previous HBS and deleting those that are no longer important based on their shares in the HBS.

***Introducing New Weights and the Consumer Price Index Basket.** The new basket is then used to review the sample of items and outlets to ensure that the samples are representative of products being purchased by consumers and the places in which they are purchased. The new weights and sample are used to start a new CPI with updated weight and price reference periods. Typically, the weight reference period preceeds the price reference period. The NSO must decide how the new weights and sample will be introduced in the CPI. It also must decide on the price reference period, if it will differ from the weight reference period. If the price reference period and weight reference period are the same (Laspeyres), then the new sample is used to compile the CPI directly. If the two periods differ, most likely with the weight period preceding the price reference period, there are two main options for updating the CPI weights. One approach is to price update the weights to the price reference period (Lowe index) to keep the implied quantities fixed at the weight reference period levels. The second approach is to keep the expenditure shares fixed
(Young index).

A key issue in the decision is whether there has been substantial price change between the weight reference period and the price reference period when the weights are introduced into the CPI. Generally, if there is a substantial price change between the price and weight reference periods, the weights should not be price updated. As noted previously, price updating the weights

assumes that the quantities have remained fixed. If prices have changed substantially, this assumption is less likely to be true. It would be more realistic to assume the expenditure shares have remained fixed, in which case the price change is offset by a compensating quantity change. Products may disappear and have to be replaced by others, but it may also be appropriate to drop some products before they disappear altogether if they have become unrepresentative. Price collectors need to be provided with appropriate training and very clear instructions and documentation about how to proceed. Clear instructions are also needed to ensure that price collectors collect the right prices when there are sales, special offers, or other exceptional circumstances. The price data collected must also be subjected to careful checking and editing. Many checks can be carried out automatically, using standard statistical control methods. It may also be useful to send out auditors to accompany price collectors and monitor their work. The head office staff also need to be trained on index methods and procedures for review of collected data, imputation of missing data, quality-adjustment procedures when needed, as well as index compilation and dissemination processes. Improvements in information technology should obviously be fully exploited. New and more efficient computers and database applications are continuously being developed. As resources permit, new technologies and organization improvements should be implemented. Staff training and process reviews are an essential part of continuous quality improvement. Staff should receive regular training in their discipline and should be invited to operational reviews where all team members can raise concerns and, where appropriate, tackle specific issues through individual or group training.

3.0.32 Publication and Dissemination. As noted previously, the CPI is an important statistic whose movements can influence the central bank's monetary policy, fiscal policy, and the national budget; affect stock markets; influence wage rates and social security payments; and so on. There must be public confidence in its reliability, and in the competence and integrity of those responsible for its compilation. The methods used to compile it must therefore be fully documented, transparent, and open to public scrutiny. Many countries have an official CPI advisory group consisting of both experts and users. The role of such a group is not just to advise the NSO on technical matters, but also to promote public confidence in the index. Users of the index also attach great importance to having the index published as soon as possible after the end of each month or quarter, preferably within two or three weeks. There are also many users who do not wish the index to be revised once it has been published. Thus, there is likely to be some trade-off between the timeliness and the quality of the index.

Publication should be understood to mean the dissemination of the results in any form. Most countries do not release their CPI in print, or hard copy. NSOs now tend to release the CPI electronically and make it available through the internet on their website. As explained in Chapter 14, good publication policy goes beyond timeliness, confidence, and transparency.
The results should be made available to all users, in both the public and the private sectors, at the same time and weights are introduced there should be an overlap period for the two indices so that they can be linked together. The overlap period is used to develop adjustment factors that may be applied to the old series to bring it to the same level as the new series. The linking of the old and new index series creates a continuous time series of data, which users need. At minimum, a single common period is required as an overlap period between the indices. While a single overlap period can be used when the CPI is updated annually, this is not the preferred method when the index is updated less frequently. In the case of infrequent updates, an annual

overlap is preferred. Some NSOs update the CPI weights each year so that the time lapse between the weight reference period and the link month is short. The single period link could be used in these instances. Chapter 9 provides a detailed discussion of annual weight updates.

Most NSOs will establish a new index reference period using an annual average from a previous year. The simplest and easiest method for users is to link the series with data for the month preceding the introduction of the new series (link month). This involves re-referencing the old series at each level to the annual average index for the new price reference period. However, there will be a discontinuity between the index level for the new index and that for the re-referenced index level for the old series in the link month. This reflects the difference in price trends between the old and new series as the new weights are being introduced. There are three steps involved to link this difference: Re-reference the old index series to the new index reference Period Compile the new index series in the link month using the new weight structure Link the new series to the old series by using forward linking factors or, if using the short-term price relative method, start the new series indices at the level of the old series in the link month If the NSO or users want to continue the old CPI series for future periods in time, they can produce a set of forward linking factors to use in future months as the new CPI is released. The forward linking factor raises the level of the new CPI series to that of the old series thus keeping the series on the old reference period.

***Organization and Management.** The production of the CPI is a complex operation involving extensive fieldwork by data collectors; processing, review, and editing of the collected data; compilation of indices; and their dissemination to the public. The whole process requires careful planning and management to ensure that the data products conform to good management and statistical practice. Price collectors should be well trained to ensure that they understand the importance of selecting the right products for pricing. Inevitably, price collectors are bound to use their own discretion to a considerable extent. As already explained, one issue of crucial importance to the quality and reliability of a CPI is how to deal with the slowly evolving set of products with which a price collector is confronted. internet purchases, second-hand goods, own-account production, tariffs, transport services, health, education, social protection, and financial services. Wherever possible, the chapter identifies the preferred approach for the treatment of each special case; however, currently there is no preferred approach for the treatment of owner-occupied housing services. In terms of housing the different possible methods for the treatment of owner-occupied housing are described with the advantages and disadvantages of each method.

***Errors and Biases.** The CPI, like all other statistics, may be subject process but also errors that are unique to the CPI (for example, substitution bias and quality change bias). It describes not only the different types and sources of potential errors, but also potential biases and their sources are described and provides insight into how to address these errors and biases. according to a publication schedule announced in advance. There should be no discrimination among users in the timing of the release of the results. The results should not be subject to governmental scrutiny as a condition for their release and should be seen to be free from political or other pressures. There are many decisions to be taken about the degree of detail in the published data and the different ways in which the results may be presented. Users need to be consulted about these questions. However, it is recommended to provide users with detailed data that are presented in a long time series. Detailed indices should include detailed item and area indices. **Special Cases.**

Certain products and issues have proven to be challenging for compilers with regard to both developing weights and collecting prices, which focuses on selected special cases and provides detailed advice for some of the more problematic products and issues compilers face. These include the treatment of seasonal items, housing,

3.1 Analytical Framework, Concepts, Definitions and Classifications

3.1.1 Definition

The Sierra Leone National Consumer Price Index (all urban) measures pure price change in the 12 COICOP functions of products and services consumed by the residents of Sierra Leone, which have been provided at constant quality. The overall aim is to measure the levels of increases or decreases in the prices of the items consumed and in essence ascertain the cost of living for the inhabitants of Sierra Leone. The consumer Price Index (CPI) is the instrument to measure inflation. It is used to estimate the average variation between two given periods in the prices of products consumed by households. It is a composite measurement of trends in the prices of products, at constant quality. Inflation is an increase in the overall price level. The official inflation rate is tracked by calculating changes in a measure called the consumer price index (CPI). The CPI tracks changes in the cost of living over time. The quoted inflation rate is actually the change in the index from the prior period, whether it is monthly, quarterly, or yearly. Changes in the CPI reflect price changes in the economy. When there is an upward change in the CPI, this means there has been an increase in the average change in prices over time. Inflation is an increase in the overall price level. The official inflation rate is tracked by calculating changes in a measure called the CPI. The CPI tracks changes in the cost of living over time.

The Consumer Price describes the price development of goods and services purchased in Sierra Leone by households resident in Sierra Leone. It measures the proportionate or percentage changes in the prices of a representative basket of goods and services over time. The Consumer Price Index is calculated with a method in which the prices of different commodities are weighed together with their shares of consumption. Thus the Sierra Leone national CPI is computed as the weighted average of the percentage price changes for a representative and carefully selected set of 400 goods and services normally consumed by resident households, the weights been derived from the Sierra Leone Integrated Household Survey of 2003/2004 price updated to May 2007. The calculation of the index follows the modified Laspeyres' price index formula whereby the shares of consumption used as the weights relate to the base period chained such that the prices in each period are compared with those in the previous period. Consumer Price Index (CPI) is a price index, the price of a weighted average market basket of consumer goods and services purchased by households. Changes in measured CPI track changes in price over time. The index measures the overall change in consumer price based on a representative basket of goods and services over time.

In the US the Consumer Price Index (CPI) measures the monthly change in prices paid by U.S consumers. The Bureau of Labor Statistics (BLS) calculates the CPI as a weighted average of prices for a basket of goods and services representative of aggregate U.S consumer spending. The CPI is one of the most popular measures of inflation and deflation. The CPI report uses a different survey methodology, price samples, and index weights than the Producer Price Index (PPI), which measures changes in the prices received by U.S producers of goods and services. It

measures the overall change in consumer prices based on a representative basket of goods and services over time. The CPI is the most widely used measure of inflation, closely followed by policy makers, financial markets, businesses, and consumers. The widely quoted CPI is based on an index covering 93 percent of the U.S population, while a related index covering wage earners and clerical workers is used for cost-of-living adjustments to federal benefits. The CPI is based on about 80,000 price quotes collected monthly from some 23,000 retail and service establishments as well as 50,000 rental housing units. Housing rents are used to estimate the change in shelter costs including owner-occupied housing that account for about a third of the CPI. The BLS collects about 80,000 prices monthly from some 23,000 retail and service establishments. Although the two CPI indexes calculated from the data both contain the word urban, the more broad-based and widely cited of the two covers 93 percent of the U.S population. Shelter category prices accounting for a third of the overall CPI are based on a survey of rental prices for 50,000 housing units, which is then used to calculate the rise in rental prices as well as owner's equivalent. The owners' equivalent category models the rent equivalent for owner-occupied housing to properly reflect housing costs' share of consumer spending. User fees and sales or excise taxes are included, while income taxes and the prices of investments such as stocks, bonds, or life insurances policies are not part of the CPI. The calculation of the CPI indexes from the data factors in substitution effects – consumers' tendency to shift spending away from products and categories has grown relatively more expensive. It also adjusts price data for changes in product quality and features. The weighting of the product and service categories in the CPI indexes corresponds to recent consumer spending patterns derived from a separate survey.

3.1.2 Consumer Price Index (CPI) data collection methodology in the United States. About 10,000 segments were selected in the PSUs. The housing sample is designed to consist of approximately 50,000 rental units. Sampling rates were computed for each segment so that the sample design would be realized after the sampling and screening processes described next were completed. Sample allocation to PSUs. BLS allocated the sample to PSUs based on the estimated total housing expenditure in each PSU. The estimated total housing PSU expenditure is the sum of the total cost of housing, previously defined, across all segments: PSU expenditure $\sum TC \,.\, s \in S = s$ There are six collection panels. It was desired that the segment sample size be equal within each collection panel. Thus, the segments were allocated in blocks of 6 segments, with a minimum of 72 segments per PSU. For PSUs with multiple replicates, it was desired to have at least 36 segments per replicate and an equal sample size in each replicate. It was determined that a minimum of 108 segments was needed to support publication in areas that were published semiannually and that a minimum of 180 segments was needed for areas that are published bimonthly. The one exception was Baltimore, which received 108 segments but is published bimonthly as part of the Washington–Baltimore CMSA. As the sample size was previously about 10,000 segments and the budget for housing data collection was comparable, multiples of 6 segments were chosen so that the total would be near 10,000 segments. Sampling housing units. After segments have been chosen for each PSU, housing units are chosen for collection within each segment. Lists of housing units are obtained for each segment and an equal probability sample is chosen. In most cases, the target number of rental units from each segment is five. Prior to sampling, the housing units are ordered by address and the sample taken is systematic, ensuring a geographic spread of housing units selected within the segment.

The sampling rate varies from segment to segment, depending on the expected percentage of rental and owned units within the segment. Collection. Collection includes the screening of the selected housing units to determine if the units are in scope for the housing sample. If the unit is in scope, it is initiated. Initiation is the initial collection of rent data, which consists of the rent paid and the specific housing services that are associated with the unit and the rent paid. These data are the basis for all calculations of rent change that occurs during the life of the unit in the housing sample. After initiation, the housing unit is priced on panel every 6months. Pricing is very similar to the initiation process, but some previous answers are provided. The collection of the housing data, and particularly the rent data, is independent. That is, the field staff collects the data without giving the respondent the previous answer. Previous answers for some non-rent data are provided, so that the field staff can confirm certain changes with the respondent. Inherent in all of the structured housing questionnaires (screening, initiation, and pricing) are various flow determinations (skip patterns), such that the answer to one question determines the next question that must be asked or answered. The CADC instrument. The CADC instrument receives the screening/initiation schedules electronically. Even though the schedules have been assigned to specific panels, the field staff has several months to collect the screening/initiation schedules. This is referred to as the non-monthly period. The field staff obtains answers to various (screening) questions (through observation and through direct questioning of eligible respondents) that determine whether an address is in scope for the housing sample. The screening criteria consist of tenure (whether the unit is renter or owner occupied) and other criteria, such as not being in public housing projects, being a primary residence, and the tenant not being a relative of the landlord. With the computer, the skip patterns can be very efficient. Because the computer has stored all of the previously collected data, automated logic checks remove all redundant question patterns, thereby reducing the field staff's work and the respondent's burden. Automated data checking ensures that only correct data types are collected, other automated logic checks ensure that collected data are consistent.

3.1.3 Analytical Framework

The Sierra Leone CPI is compiled using the modified Laspeyres' type formula. The elementary aggregate indices are computed as Jevons indices (i.e. geometric mean of price ratios) to eliminate the possible upward bias of the Carli or Dutot type elementary aggregate indices. The CPI represents changes in prices of all goods and services purchased for consumption by urban households. User fees (such as water and sewer services) and sales and excise taxes paid by the consumer are also included. Income taxes and investment items (like stocks, bonds, and life insurance) are included. The CPI consists of a family of indexes that measure price change experienced by urban consumers. Specifically, the CPI measures the average change in price over time of a market basket of consumer goods and services. The market basket includes everything from food items to automobiles to rent. The CPI is perhaps the most noted measure of consumer inflation in the United States, and it is used by policy makers to understand and analyze the economy. It is used in many official contexts, for example to escalate Social Security and other federal payments, to adjust tax brackets, to deflate other time series data, and to convert nominal dollars to real dollars. It is also widely used by businesses and private citizens to adjust wages and to escalate rents and other payments. For the US Bureau of Labor Statistics (BLS) has classified all expenditure items into more than 200 categories, arranged into eight major groups (food and beverages, housing, apparel, transportation, medical care, recreation,

education and communication, and other goods and services). It publishes CPI for All Urban Consumers (CPI-U), CPI for Urban Wage Earners and Clerical Workers (CPI-W), Chained CPI for All Urban Consumers (C-CPI-U), and Average prices.

This item structure is unique to the CPI and the categories themselves do not correspond to the North American industry Classification System (NAICS), other price indexes, or other statistics. The eight major groups and examples of categories in each follow: Food and beverages (breakfast cereal, milk, coffee, chicken, wine, full service meals, snacks). Housing (rent of primary residence, owners' equivalent rent, utilities, bedroom furniture). Apparel (men's shirts and sweaters, women's dresses, baby clothes, shoes, jewelry). Transportation (new vehicles, airline fares, gasoline, motor vehicle insurance). Medical care (prescription drugs, medical equipment and supplies, physicians services, eyeglasses and eye care, hospital services). Recreation (television, toys, pets and pet products, sports equipment, park and museum admissions). Education and communication (college tuition, postage, telephone services, computer software and accessories). Other goods and services (tobacco and smoking products, haircuts and other personal services, funeral expenses). Additionally, for analytical purpose, the CPI is also divided into food, energy, and all items less food and energy. The CPI for all items less food and energy gets considerable attention as a measure of underlying core inflation, which is not subject to the volatile movements of food and energy prices. A third structure separates the CPI into commodities and services, with commodities further divided into durables and nondurables. All three structures are comprehensive, with the subcomponents in each structure aggregating to the all items index.

The CPI as a cost-of-living framework: The CPI is widely used as a cost-of-living index (COLI), which answers the hypothetical question concerning what expenditure level is needed to achieve a standard of living attained in a base period at current market prices. The ratio of this hypothetical cost to the actual cost of the base-period consumption basket in the base period is the COLI. The cost of living is affected by many things not captured in market transactions, and the cost of achieving a living standard cannot be observed directly, so the CPI only approximates a cost-of-living index. The CPI is sometimes called a conditional COLI, since the factors that affect the cost of living that are not in scope are implicitly held constant. The concept of the COLI provides the CPI measurement objective and is the standard by which any bias in the CPI is defined. The CPI is constructed using a set of interlocking surveys, and it is fundamentally a measure of price change. The CPI follows the prices of a sample of items in various categories of consumer spending, encompassing a majority of all goods and services purchased by urban consumers for consumption. The CPI focuses on the consumer experience of inflation, therefore the price sought is typically the consumer's out-of-pocket price, including sales and excise taxes. (This contrasts with the Producer Price Index, which focuses on what is received by the producer.) Prices are collected during the course of the entire month, with a certain amount of price data collected in each of three pricing periods. CPI data correspond to a month, not a specific data. The monthly movement in the CPI comes from wighted average of the price changes of the items in the CPI sample. A sample item's price change is the ratio of its price at the current time to its price in a previous time.

Population: The CPI is computed officially for two different populations. The CPI for all urban consumers (CPI-U) is the broadest measure and is the most widely used CPI. It is based on the

expenditure patterns of a sample of urban consumers representing over 90 percent of the population. Not included in the CPI are the spending patterns of people living in rural nonmetropolitan areas, farm households, people in the Armed Forces, and those in institutions, such as prisons and mental hospitals. Consumer inflation for all urban consumers is measured by two indexes-namely, the CPI-U and the Chained Consumer Price Index for All Urban Consumers (C-CPI-U). The Consumer Price Index for Urban Wage Earners and Clerical Workers (CPI-W) is based on the expenditures of urban households included in the CPI-U definition that also meet two additional requirements: more than one-half of the household's income must come from clerical or wage occupations, and at least one of the household's earners must have been employed for at least 37 weeks during the previous 12 months. The CPI-W population represents approximately 30 percent of the total U.S. population and is a subset of the CPI-U population.

Seasonality: Expenditure patterns can change dramatically during the year, for example, around holidays. A statistical process called seasonal adjustment can be done to remove typical seasonal influences, which helps economists better identify underlying trends, CPI publishes both seasonally adjusted (NSA) data and not seasonally adjusted data (NSA) data. Seasonally adjusted data are typically used to understand and analyze month-to-month-price change; not seasonally adjusted data are typically used for official purposes, including escalation of government payments and for studying longer term price movement. Seasonally adjusted data are only published at the nationwide level, and not all categories are seasonally adjusted. For the U.S. Excluded Goods and Services, The CPI covers the consumption sector of the U.S. economy, which is defined as the purchase of goods and services for use by households. Consequently, the CPI excludes investment items, such as stocks, bonds, real estate, and business expenses. Life insurance is also excluded for this reason, although health, household, and vehicle insurance are in scope. Employer provided in-kind benefits are viewed as part of income rather than consumption. Purchases of houses, antiques, and collectibles are viewed as investment expenditures and therefore excluded. Gambling losses, fines, cash gifts to individuals or charities, and child support and alimony payments also are out of scope. Internet costs and finance charges are also out of scope. Interest costs and finance charges are also out of scope. The CPI excludes illegal goods and services and the value of home produced items because of the practical difficulties of collecting the data. Taxes: The CPI excludes income tax and other direct taxes; however, it does include the effects of changes in sales taxes and other indirect taxes paid on consumer products. No attempt is made to reflect changes in the quantity or quality of government services paid for through taxes.

Classification system
The Sierra Leone CPI basket is classified according to the Classification of Individual Consumption by Purpose (COICOP) into 12 Functions, 40 groups, 82 sub-groups or classes.

3.1.4 Reference population
The CPI refers to all resident households of Sierra Leone.

3.1.5 Geographic coverage
The index includes sampled outlets from five urban towns representing the four geographic regions of the country. The district head quarter towns of Kenema and Koidu were purposefully selected to represent the Eastern Region, Bo was selected to represent Southern Region, Makeni represents the Northern Region while Freetown represents the Western Area. The weights applied to the computation of the composite index refer to the entire country divided into the four regions.

3.1.6 Item coverage
The basket of 400 items relates to popular items consumed by all inhabitants of Sierra Leone. These items are divided into the 12 functions of COICOP namely; (i) Food and Non-Alcoholic Beverages; (ii) Alcoholic Beverages, Tobacco and Narcotics; (iii) Clothing & Footwear; (iv)Housing, Water, Electricity Gas and Other Fuels, (v) Furniture, Household Equipment and Routine Household Maintenance,(vi) Health, (vii)Transport, (viii) Communication, (ix) Recreation and Culture, (x)Education, (xi) Restaurants and Hotels, (xii) Miscellaneous Goods and Services.

3.1.7 timing of price observations: Prices for the 64 items priced weekly are recorded on every Thursday of the week by price collectors visiting the selected markets and outlets from 10 am to 3 pm. The price collection for the other items are divided into 12 monthly surveys so that by the end of the first week the Food and Non-Alcoholic Beverages and Alcoholic Beverages, Tobacco and Narcotics surveys are completed, during the second week prices are collected for Clothing & Footwear, Housing, Water, Electricity Gas and Other Fuels, in the third week the Furniture, Household Equipment and Routine Household Maintenance, Health, Transport, and Communication surveys are carried out and during the fourth week, the Recreation and Culture, Restaurants and Hotels, and Miscellaneous Goods and Services surveys are conducted. For each of these surveys some products within the basket for which prices do not often change are isolated for quarterly data collection. The Education Survey is carried out once every year at the start of the school year while the rent survey is carried out twice every year, in December and June of every year. **3.8 Types of prices included** The prices recorded are actual transaction prices. In most of the outlets, the quoted prices are inclusive of all applicable taxes. Where taxes are charged separately, for example in hotels and restaurants, the CPI price includes VAT, excise tax, sales tax and other indirect taxes applicable.

3.2 Nature of Basic Data Sources

3.2.1 Sources of weights
The CPI weights are taken from the Sierra Leone Integrated Household Budget Survey conducted by Statistics Sierra Leone using a two-stage random sample of approximately 3250

households. The target sample size selected for the 2003/2004 Sierra Leone Integrated Household Survey was 3,000 households; and the final size in the data set is 3,250 households. The size was small due to budget constraints and inadequate human resources. In the survey, a household was defined as a group of persons who usually sleep in the same dwelling and take their meals together or eat from the same pot for at least 9 months preceding the interview.

The sample was a self-weighted sample drawn from all areas of Sierra Leone. The overall sampling frame was stratified into two strata, urban and rural, with sampling carried out separately in each stratum. The Enumeration Area (EA) was the Primary Sampling Unit with an average population of 1,645. Based on revised population estimates, about 33% of Sierra Leoneans households live in the rural areas so the sample stratification ensured that 33% of selected households came from the rural areas. Urban settlements were regarded as those with a population of 2000 or more. All EAs in these settlements were therefore regarded as urban EAs. The sample for the Sierra Leone Integrated Household Survey was drawn in two stages with the Enumeration Areas chosen as the Primary Sampling Unit (PSU). A total of 200 EAs were selected systematically out of the 2,553 EAs with probability proportional to their population size. In the first stage, about, 50 Urban EAs and 150 Rural EAs were selected systematically with a random start and fixed interval of 11 = (150/50) for the Urban Area) and 13 = (1,993/150) for the Rural Areas. The second stage involved the listing of all households within each selected EA and selecting 1,000 households in the Urban Area and 2,250 households in the Rural Areas. In order to ensure that the timeframe excludes the effects of seasonality, this survey uses the method of rotating the sample whereby the 3,250 surveyed households were divided into 10 sub-samples with survey duration of a month each.

3.2.2 Time period of current weights

The weights provided by the 2003/2004 Sierra Leone Integrated Household Survey (SLIHS) were updated to May 2007 to ensure that the weight reference period coincides with the price reference period.

3.2.3 Outlet selection

The old CPI outlet sample was completely revised. The outlet sample for the new CPI (2006/07=100) was selected using ordered probability proportional to size sampling. This procedure is fully explained in the Consumer Price Index (CPI) Manual (2004). The Sierra Leone Business Register, compiled in 2005 and updated annually, was used as sampling frame. The list of establishments was classified by type with an indication of the number of employees as size measure and the type of products sold or services rendered. The outlets were re-organised for each selected CPI center and in each center by the main COICOP functions using the main product of the outlets to inform the grouping.

For a given outlet type, the number of employees was represented by xi and a random number Ui between 0 and 1 was associated it with each outlet. A variable Z such that $Z = nxi/\Sigma xi$, where n is sample size, xi is the number of employees in outlet i. (i =1,2,3…N) and Σxi is the cumulative total number of employees for all outlets of the specified type was computed. The ranking variable Q which is a function of Z such that $Qi = Ui(1-Zi)/ Zi(1-Ui)$ where Zi and Ui are defined as above. The values of Q is obtained were sorted in ascending order and for each product in the basket the 3 outlets with the smallest value of the ranking variable (Q) were selected. The ranking is very useful because during field work the outlets that were found to be unsuitable were replaced with the next ones in the ranking. Thus ordered PPS provide some flexibility.

3.2.4 Product/outlet selection

First 130 elementary aggregate were selected based on their expenditure weight as computed by the SLIHS. Then the specific products priced were purposefully selected based on their representatively. Considerable information on the availability and representatively of products was gathered during the 2003 to 2006 rounds of ICP surveys. This information was used to determine whether specific products were volume sellers are available on a national scale. Products were selected within each retail outlet giving careful consideration to taste and income of the consumers in the center where the outlet is located.

3.2.5 Sample sizes

Five urban centers were purposefully selected for data collection. The four centers already used for price collection, Freetown, Bo, Kenema and Makeni were retained. Koidu which is a major diamond mining town was added. For each product three outlets were selected for price collection. However, for a few products price collection was done in less than three outlets due to centralization of services.

3.2.6 Price collection methods

Personal visits and paper collection forms are used to collect prices in all retail outlets. The CPI survey collects prices per month to compute indexes for commodities and services. Approximately two-thirds of price collection in the CPI is done by personal visits of CPI data collectors to brick-and-mortar stores. The remaining data are collected by telephone or on the

outlet's website. The CPI is constructed using a set of interlocking surveys, and is fundamentally a measure of price change. The CPI follows the prices of a sample of items in various categories of consumer spending, encompassing a majority of all goods and services purchased by urban consumers for consumption. The Not Seasonally Adjusted monthly index shows that the CPI at 3.41 percent, June 2023 544.08 percent and May 2023 526.15 percent. In the U.S., for 2022, 22 of the 81 components of the U.S. city average all items index are seasonally adjusted. Contact information for additional information about the CPI visit www.bls.gov/cpi or contact the CPI information and Analysis Section at 202-691-7000 or cpi_info@bls.gov.

3.2.7 Data collection and compilation

Personal visits and paper collection forms are used to collect prices in all retail outlets;
CPI data collection is divided into 12 regular surveys based on the 12 functions of COICOP; each survey is organized according to periodicity; regularity of survey is weekly, monthly, quarterly and semi-annually or yearly. Market days for CPI are Wednesday, Thursday and Friday of every week.

3.3 Estimation Procedures

3.3.1 Price Indices

The method used to compute the CPI in Sierra Leone is the modified Laspeyres Price Index which is part of the ECOWAS harmonization program on price levels in West Africa. In this regard, the CPI is defined as the sum of the multiplicand of a price relative and a corresponding expenditure weights for each item in the CPI basket. A Price Relative is defined as the ratio of current year price to base year price for each item, and expenditure weights are determined using aggregates derived from the Sierra Leone Integrated Household Survey (SLIHS) Income and Expenditure Module. These aggregates are determined using the Classification of Individual Consumption of Purpose (COICOP) for Household Final Consumption Expenditure with 2007 as the new base year. The COICOP classification which is an international standard to disaggregate the CPI has 12 functions excluding the function of "All Items" which is the basket of all functions. The 12 COICOP functions are:

- Food and non-Alcoholic Beverages
- Alcoholic Beverages, Tobacco and Narcotics
- Clothing and Footwear
- Housing, water, electricity, gas and other fuels
- Furnishing, household equipment and maintenance
- Health
- Transport
- Communication
- Recreation and culture
- Education
- Hotels and Restaurants
- Miscellaneous goods and services. Consequently, a CPI is computed for each of the 12 functions in the basket using the items as classified according to COICOP.

3.3.2 Aggregation of CPIs Centers

For the Eastern province index, the average price of the elementary aggregates is computed as the weighted average of the separate center elementary aggregate prices (Kenema and Kono). The average obtained is used in the compilation process by applying the Eastern Province combined weights. For the national index, the national elementary aggregate price is computed as the weighted average of the elementary average prices of all provinces, the expenditure share of each province on the elementary aggregate used as weight.

3.3.3 Price Adjustment Techniques

Missing prices: When a price observation is temporarily unavailable in a given outlet, its price is imputed based upon the price movement of group of products within the same stratum.

Replacement Outlet: When a specific outlet is permanently out of business in a given center, another outlet with similar characteristics is selected to replace it.

Replacement products: When a product is permanently unavailable a similar product with the same elementary aggregate that most closely meets the specifications of the previous product is selected as a replacement product.

Quality differences: Adjustments are made to correct quality differences. Overlap imputation procedure is used (where information on the price of other products in the same outlet is available). Otherwise we use class mean imputation.

Verification procedures: Detailed manual editing is done before prices are inputted into the computer. Inputted data is also subjected to computer editing. Limits to price increases or decreases which identify exception cases for analyst review are set at 30 per cent. Any price change (up or down) above 30% from the previous month, would require field verification to confirm the actual price as well as the reasons for the change, and only the verified price is included in the estimation of the CPI for that month.

Reference period: May 2006 to May 2007(2006/2007) = 100. Please note that the Sierra Leone CPI base year has now been recently updated since 2022, therefore the data set under consideration spans only up till 2021.

3.3.4 Method used to combine basic price observations

Geometric mean formula is used to compute the mean of prices observed for each product by elementary aggregate.

Formula for aggregation:

For the aggregation of basic indexes Modified Laspeyres aggregation is used.

$CPI^t = \sum^4_{i=1} W^b_i \text{ x } I^t_i$

Where

W^b_i is the basic weight of the group of product and

I^t_i is the elementary index for the group of product (i) in the period (t).

3.3.5 Method used to update weights

There are two main options for updating the CPI weights (I) price-updating the weights to the price reference period (Lowe index) to keep the implied quantities fixed at the weight reference period levels or (II) simply introducing the weights (Young index) which keeps the expenditure shares fixed. The CPI is a complete measure that combines economic theory with sampling and other statistical techniques and uses data from several surveys to produce a timely and precise measure of average price change for the consumption sector of the American economy. The weights are calculated as the proportion of the total consumption expenditure of all goods and services included in the index basket for the reference population during the reference period. The Consumer Price Index (CPI) consists of a family of indexes that measure price change experience by urban consumers. Specifically, the CPI measures the average change in price over time of a market basket of consumer goods and services. The market basket includes everything from food items to automobiles to rent. A consumer Price Index is usually calculated as a weighted average of the price change of the goods and services covered by the index. The weights are meant to reflect the relative importance of the goods and services as measured by that shares in the total consumption of households.

The original weight reference period was 2003/2004, the year when the SLIHS was conducted for which expenditure weights are available. The SLIHS from which the weights were estimated covered the whole year which was thought of as the normal year, following the end of the war. Prices for all items in the basket were collected from May 2006 to May 2007 which serves as the price reference period. In practice the weight reference period should not be too distant from the price reference period. It was decided to re-reference the index to 2006/2007 and weight updates it to the same period. The price updated weights were computed by multiplying the 2003/2004 weights by elementary aggregate indices measuring the price changes between 2006/2007 and 2003/2004 and rescaling the results to 100. The elementary indices were computed by dividing the average prices for 2006/2007 by the elementary prices for 2003/2004. These were then multiplied by the 2003/2004 weights to derived the updated weights. This procedure preserves the 2003/2004 quantities and ensure that the resulting index is technically a basket index or a Lowe index with 2003/2004 quantities.

Chapter 4 Data Presentation and Analysis

4.0 Introduction

In this chapter the data is presented in tables and graphs and then analyzed to reflect the trend the Sierra Leone Consumer Price Index (SLCPI) has taken for the years under study, i.e. 2008 to 2022. The graphs are used to present the data for the analysis, while the actual data is shown in the tables. The tables from which the graphs are naturally derived, are disaggregated into the respective 12 COICOP functions, that are used in CPI data analyses in the West African sub region, to enhance the harmonized data collection methodologies used by a number of countries in the Economic Commission of West African States (ECOWAS) region, which allows for international comparability of Consumer Price Index (CPI) figures so generated by the National Statistics Offices (NSO) of these countries. The analysis consider the annual figures, and the monthly figures from the tables which are used to generate the annual and monthly CPI graphs. Therefore the Annual CPI graphs comprise of a single trend graph, whilst the monthly CPI graphs contains multiple line graphs each representing a month during the year. The data is analyzed on a trend basis from the highest to the lowest for both the annual and monthly figures.

As mentioned earlier, the method used to compute the CPI in Sierra Leone is the modified Laspeyres Price Index which is part of the ECOWAS harmonization program on price levels in West Africa. In this regard, the CPI is defined as the sum of the multiplicand of a price relative and a corresponding expenditure weights for each item in the CPI basket. A Price Relative is defined as the ratio of current year price to base year price for each item, and expenditure weights are determined using aggregates derived from the Sierra Leone Integrated Household Survey (SLIHS) Income and Expenditure Module. These aggregates are determined using the Classification of Individual Consumption of Purpose (COICOP) for Household Final Consumption Expenditure with 2007 as the new base year. The COICOP classification which is an international standard to disaggregate the CPI has 12 functions excluding the function of “All Items” which is the basket of all functions. The 12 COICOP functions are:

1.Food and non-Alcoholic Beverages. 2. Alcoholic Beverages, Tobacco and Narcotics. 3. Clothing and Footwear. 4. Housing, water, electricity, gas and other fuels. 5. Furnishing, household equipment and maintenance. 6. Health. 7. Transport. 8. Communication. 9. Recreation and culture. 10. Education. 11. Hotels and Restaurants. 12. Miscellaneous goods and services.

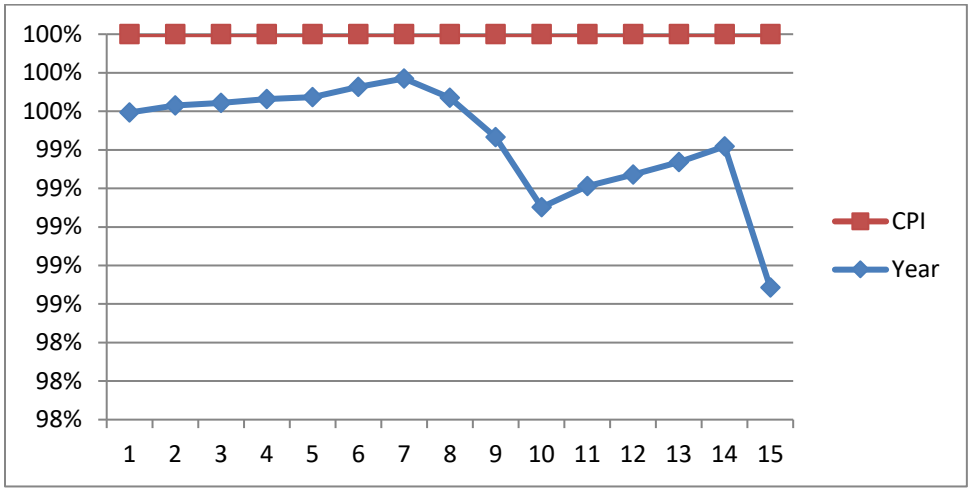
Consequently, a CPI is computed for each of the 12 functions in the basket using the items as classified according to COICOP.

Table 1. The CPI for All Items 2008 to 2022.

Month	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Jan	6.03	8.17	6.96	6.83	7.03	5.49	4.91	4.52	8.41	18.67	14.68	14.35	13.60	11.50	16.65
Feb	6.22	8.03	7.16	6.68	7.02	5.54	5.03	4.51	8.70	19.82	14.38	14.08	14.70	10.88	17.59
Mar	6.28	7.7	7.36	6.79	6.87	5.52	4.91	5.68	7.85	20.23	14.90	14.77	15.56	8.96	22.06
Apr	6.5	7.63	7.4	6.89	6.60	5.71	4.78	5.71	8.69	19.80	15.14	16.56	15.08	9.61	22.44
May	7.16	7.49	7	6.93	6.87	5.47	4.52	6.65	8.93	18.92	16.02	14.97	15.48	9.80	24.87
Jun	8.77	7.26	6.83	6.88	6.88	5.43	4.49	6.84	9.47	19.14	16.58	14.64	14.36	10.20	27.95
Jul	9.67	7.04	7.09	6.71	6.53	5.71	3.98	6.77	10.87	18.56	17.71	14.89	13.30	10.50	29.47
Aug	9.56	7.17	7.23	6.68	6.26	5.70	4.79	7.58	10.52	18.01	18.18	15.44	13.32	10.88	28.15
Sep	9.62	7.18	7.17	6.95	6.20	5.51	4.69	7.59	11.32	17.82	17.77	15.16	13.70	11.64	29.10
Oct	9.67	7.2	7.25	6.82	6.30	5.49	4.49	7.90	12.54	16.87	16.05	15.85	11.72	14.55	32.98
Nov	9.73	7.29	7.36	6.7	6.34	5.36	4.48	7.98	15.27	16.26	16.55	13.09	10.63	15.77	35.05
Dec	9.29	7.53	7.4	6.65	6.20	5.37	4.61	8.38	17.42	15.32	14.24	13.90	10.45	17.94	37.09
Annual	8.21	7.47	7.18	6.79	6.59	5.53	4.64	6.68	10.83	18.29	16.02	14.81	13.49	11.85	26.95

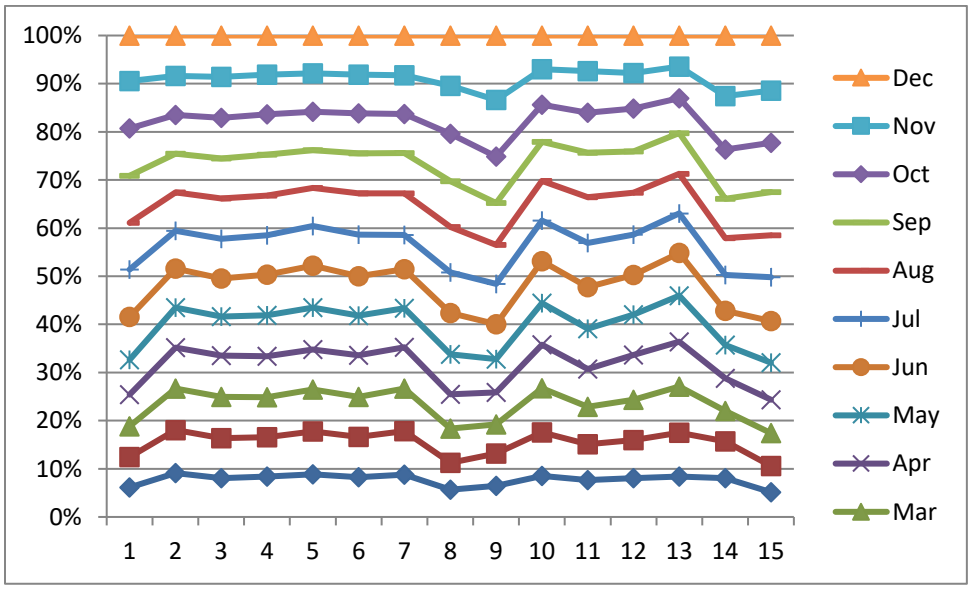
Source: Price and Labor statistics section, National Accounts and Economic statistics division, Stats SL.

1A.Annual CPI for All Items 2008 to 2022.



Annually, The CPI for All Items stands at 8.2 percent in 2008, it fell continuously year in and year out reaching its lowest in 2014 at 4.6 percent for the years under review. The CPI annual for All Items reached 10.83 percent in 2016, increasing in 2017 to 18.2 percent, falling in 2018 to 16.02 percent, further falling to 14.81 percent in 2019; 13.49 percent in 2020 and; 11.85 percent in 2021. It reached its highest in 2022 at 26.95 percent due to the increase in fuel pump prices, this essential commodity affects the prices of all other commodities.

1B.Monthly CPI for All Items 2008 to 2022.



On a monthly basis, for the period under review, the CPI for All Items is at its highest in December 2022 at 37.9 percent. Followed by November 2022 which is at 35.05 percent, then October 2022 at 32.98 percent, September 2022 at 29.1 percent, and July 2022 at 29.47

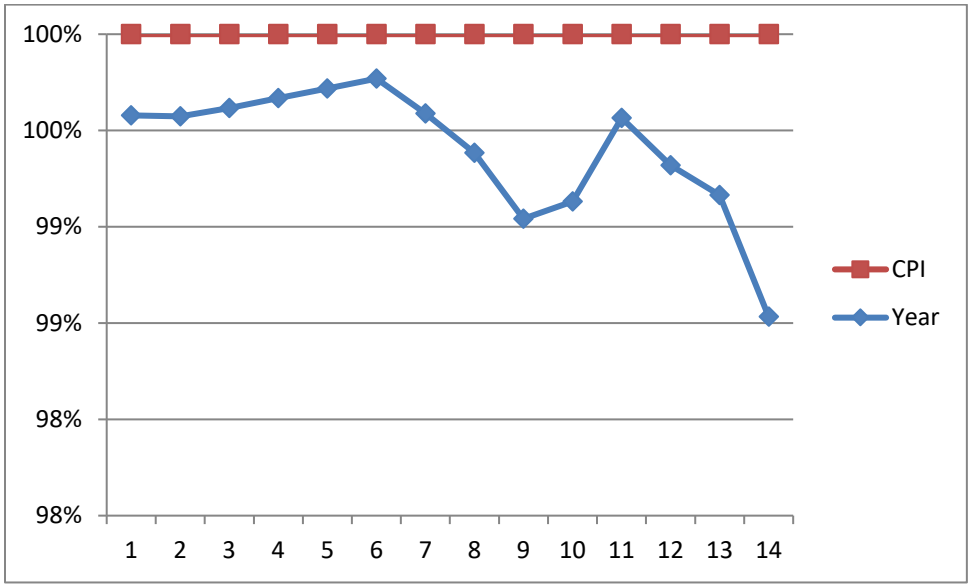
percent. The monthly CPI was at its lowest in July, 2014 standing at 3.98 percent. And, as mentioned earlier, the index was at its highest in December 2022 at 37.9 percent for the period under consideration, due to the government removing subsidy on fuel pump prices, as a condition which the World Bank and IMF require it to do in order to benefit from the Britton Woods organization's loans and grants.

Table 2. The CPI for Food and Non-alcoholic beverages 2008 to 2022.

Month	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Annual	8.51	8.30	8.60	7.75	6.71	5.68	4.66	8.34	12.50	19.51	17.69	8.81	13.85	17.02	30.11
January	5.78	8.89	8.71	7.91	7.27	5.67	4.82	5.25	10.23	20.19	17.50	10.56	7.45	18.89	15.68
February	6.15	8.73	9.09	7.56	7.15	5.63	5.14	5.18	10.54	21.52	16.87	10.50	8.31	19.59	17.09
March	6.29	8.33	9.44	7.56	6.81	5.83	4.98	6.37	9.66	22.28	16.72	12.29	9.87	15.45	22.96
April	6.78	8.04	9.22	7.91	6.50	6.13	4.71	6.58	10.84	20.95	17.21	15.91	10.54	15.64	23.00
May	7.17	8.17	8.67	8.04	6.86	5.76	4.42	8.41	10.13	19.72	18.73	7.51	16.61	17.56	26.29
June	9.17	7.98	8.32	8.01	6.77	5.57	4.38	8.92	10.74	19.60	19.64	6.64	16.93	17.12	28.49
July	9.92	7.61	8.64	7.79	6.77	5.80	4.03	8.86	12.53	19.13	19.08	7.67	17.27	15.41	30.58
August	10.11	7.77	8.34	7.8	6.54	5.94	4.91	9.46	13.10	18.07	19.78	8.28	17.73	14.89	31.60
September	10.25	8.43	8.16	7.77	6.37	5.51	4.90	9.54	13.37	18.24	20.05	8.31	17.74	13.29	35.20
October	10.46	8.37	8.18	7.59	6.55	5.44	4.55	10.26	14.04	17.55	17.26	9.08	13.68	18.17	40.14
November	10.43	8.39	8.19	7.64	6.65	5.34	4.40	10.50	16.19	18.88	16.68	3.62	14.97	18.83	43.62
December	9.56	8.88	8.26	7.47	6.24	5.59	4.63	10.75	18.62	17.93	12.77	5.39	15.09	19.40	46.70
Annual	8.51	8.30	8.60	7.75	6.71	5.68	4.66	8.34	12.50	19.51	17.69	8.81	13.85	17.02	30.11

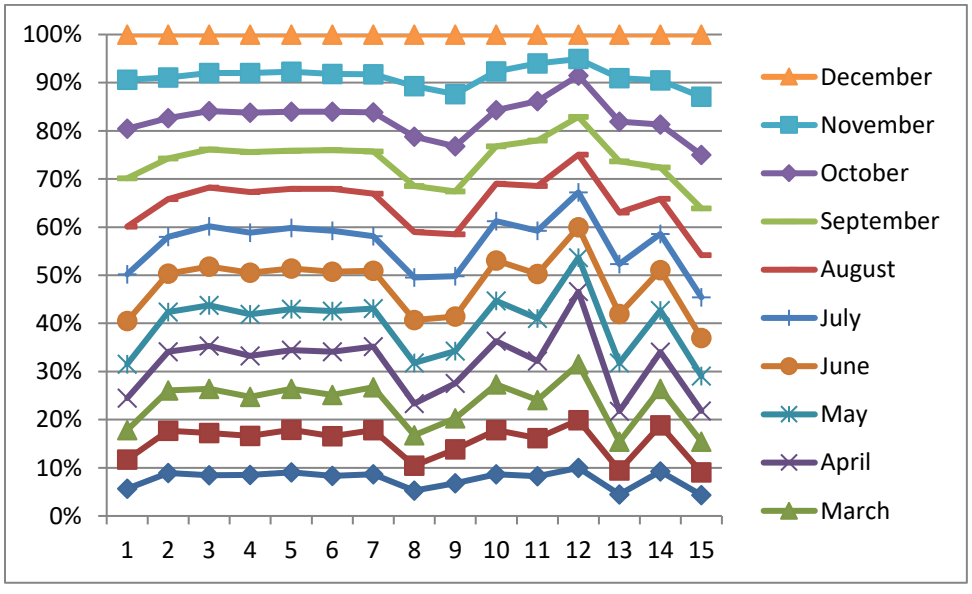
Source: Price and Labor statistics section, National Accounts and Economic statistics division, Stats SL.

2A. Annual CPI for food and Non-alcoholic beverages 2008 to 2022.



The year-on-year figures of the CPI for Food and Non-alcoholic beverages shows that for this particular COICOP function, the CPI was at its highest in 2022 at 30.11 percent, followed by 2017 at 19.51 percent, 2018 at 17.69 percent, 2021 at 17.02 percent, 2022 is at 13.85 percent, and 2016 at 12.50 percent. Annually, the CPI for Food and Non-alcoholic beverages is at its lowest in 2014 at 4.66 percent, at a time when the now long outgone APC government subsidized fuel pump prices for the benefit of its citizens.

2B. Monthly CPI for Food and Non-alcoholic beverages 2008 to 2022.



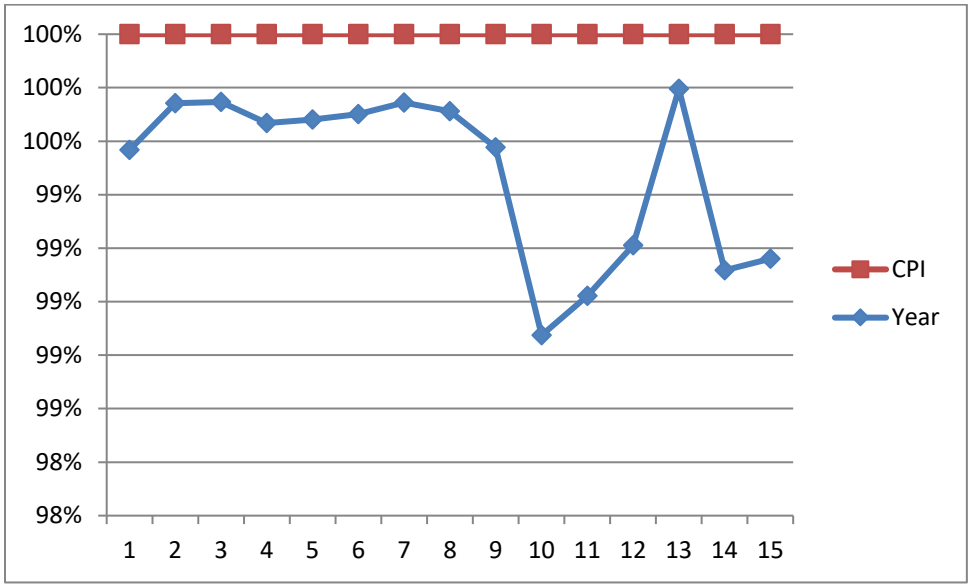
The monthly CPI for Food and Non-Alcoholic beverages from 2008 to 2022 was at its highest in December 2022 at an amazing 46.70 percent, followed by November (43.62 percent), October (40.14 percent), September (35.20 percent), August (31.60 percent), and July (30.58 percent) of that same year (2022). On the same monthly basis the CPI for Food and Non-Alcoholic beverages was at its lowest in July 2014 (4.03 percent).

Table 3. The CPI for Alcoholic beverages 2008 to 2022.

Month	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
January	8.49	4.51	4.67	6.2	5.90	6.78	5.79	4.64	5.97	18.81	20.51	19.13	10.76	2.75	24.09
February	8.31	4.47	4.92	6.66	5.86	6.44	5.77	5.00	5.40	22.00	19.52	18.93	4.00	8.26	22.28
March	8.34	4.54	5.09	6.77	6.47	6.17	5.70	5.68	4.85	24.01	18.82	17.90	4.56	9.97	23.57
April	7.34	4.9	5.03	6.88	6.18	6.45	5.25	5.78	5.41	23.92	19.38	22.17	1.62	13.80	18.77
May	7.22	6.17	4.41	6.98	5.96	6.60	5.05	5.97	6.51	22.95	20.00	18.27	4.44	12.22	20.65
June	9.38	5.84	4.19	7.24	6.00	6.34	4.99	6.13	7.77	22.59	21.01	16.25	5.84	12.17	23.72
July	9.93	5.95	5.16	6.3	5.43	6.53	4.78	5.85	8.64	22.73	21.77	16.97	3.66	19.51	17.64
August	9.88	5.43	5.57	6.3	6.11	5.93	5.55	6.09	8.43	24.80	20.38	17.56	1.65	24.21	15.74
September	8.74	5.43	5.74	6.55	7.29	4.89	5.08	6.16	9.69	24.13	22.31	12.84	2.17	28.19	3.11
October	9.09	5.3	5.55	6.68	7.24	5.29	4.97	5.96	10.78	23.84	17.39	16.10	1.10	29.65	7.96
November	9.04	4.91	5.51	6.8	7.38	5.33	4.90	5.55	14.03	22.73	22.12	4.99	3.88	30.73	13.01
December	9.07	4.79	5.51	7.13	7.33	5.68	4.19	7.11	15.19	22.96	16.23	11.55	6.01	24.41	14.84
Annual	8.74	5.19	5.11	6.71	6.43	6.04	5.17	5.83	8.56	22.96	19.95	16.06	4.14	17.99	17.12

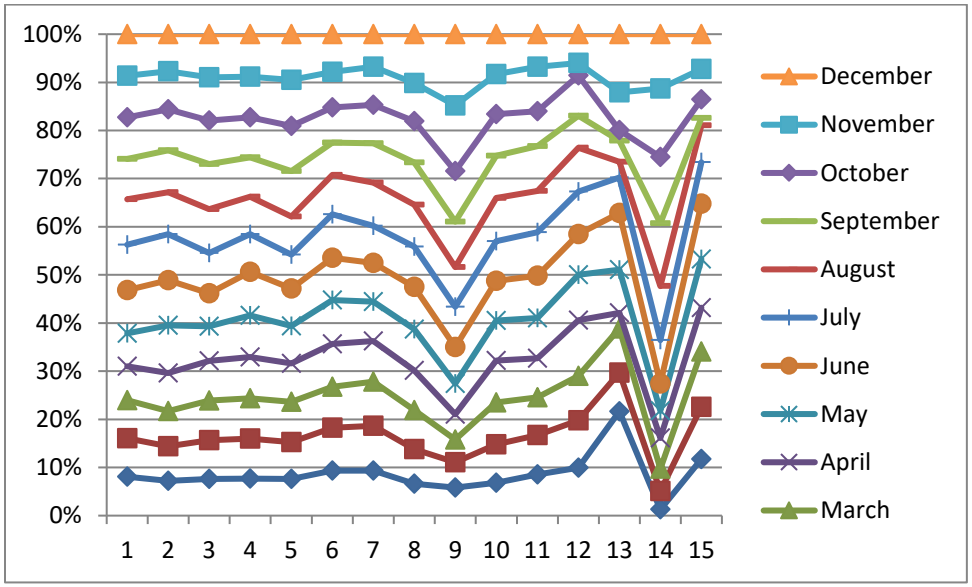
Source: Price and Labor statistics section, National Accounts and Economic statistics division, Stats SL.

3A. Annual CPI for Alcoholic beverages 2008 to 2022.



The annual CPI for Alcoholic beverages reached its highest level for the period under investigation in 2017 at 22.96 percent, to be followed by 2018 at 19.95 percent, 2021 at 17.99 percent, 2022 at 17.12 percent, 2019 at 16.06 percent, 2008 at 8.74 percent and 2016 at 8.56 percent. CPI for Alcoholic beverages from 2008 to 2022 was at its lowest in 2010 at 5.11 percent.

3B. Monthly CPI for Alcoholic beverages 2008 to 2022.



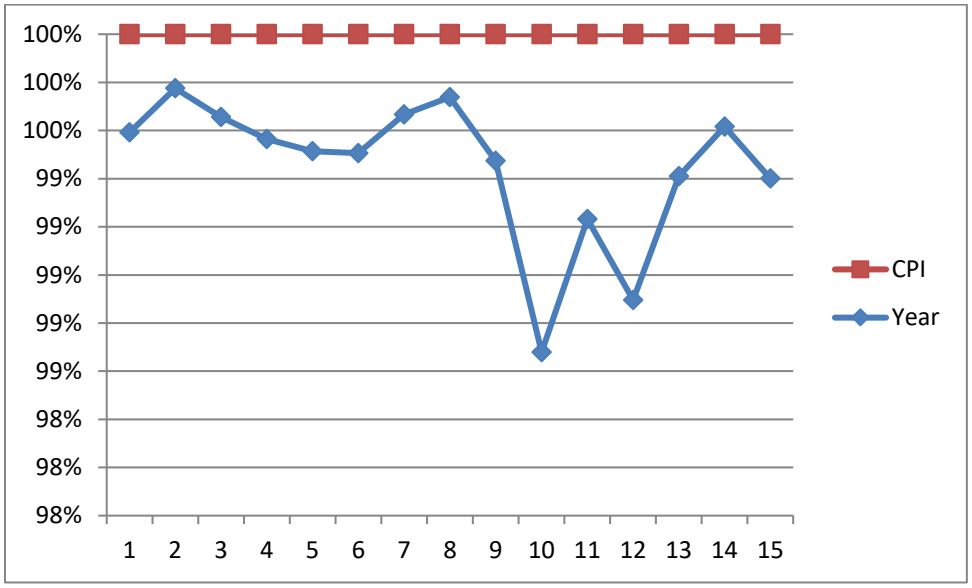
In terms of the Monthly figures, CPI for Alcoholic beverages reached its highest level for the specified period in November 2021 at 30.73 percent, chased by October 2021 at 29.65 percent, September 2021 at 28.19 percent, August 2017 at 24.80 percent, December 2021 at 24.41 percent, August 2021 at 24.21 percent, September 2017 at 24.13 percent, reaching its lowest in October 2020 at 1.10 percent for the period in question.

Table 4. The CPI for Clothing and footwear 2008 to 2022.

Month	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Jan	6.54	5.28	5.75	8.75	8.23	10.29	9.36	4.10	5.82	27.32	16.41	23.79	8.15	15.37	3.46
Feb	6.34	5.36	5.57	8.98	9.09	10.47	8.25	4.47	5.86	29.49	15.05	21.65	10.10	12.95	5.81
Mar	6.22	5.13	5.86	9.1	9.40	9.98	8.11	5.28	5.19	29.28	16.09	23.01	10.33	8.74	8.51
Apr	6.66	5.01	6.23	9.1	9.60	9.27	8.43	5.16	5.73	29.26	15.43	24.13	10.43	10.56	7.35
May	7.06	4.82	6.57	8.93	10.25	9.20	7.50	5.34	7.72	28.62	14.97	26.38	8.30	6.49	12.09
Jun	9.23	3.93	6.68	8.94	10.53	9.90	6.53	5.33	8.79	30.22	13.65	27.38	7.87	5.91	13.19
Jul	9.48	3.66	7.07	8.74	10.62	9.92	5.96	5.60	11.00	27.94	14.14	28.98	7.32	5.85	13.77
Aug	9.31	4.11	6.98	8.76	10.56	10.14	5.83	5.88	11.36	26.71	16.65	21.71	12.97	5.82	13.09
Sep	9.65	4.13	7.42	8.79	9.84	10.48	5.65	5.64	12.26	26.66	15.81	21.61	13.43	4.97	15.01
Oct	9.48	4	8.56	8.11	9.97	10.26	5.35	5.63	13.97	25.29	16.36	19.98	18.25	4.48	13.69
Nov	9.42	4.41	8.21	8.79	9.75	10.32	4.93	5.57	18.04	22.33	18.46	16.08	17.40	5.44	18.70
Dec	9.3	4.48	8.38	8.74	10.11	9.91	4.88	5.34	22.26	20.88	14.34	15.77	19.15	7.07	21.52
Annual	8.22	4.53	6.94	8.81	9.83	10.01	6.73	5.28	10.67	27.00	15.61	22.54	11.98	7.80	12.18

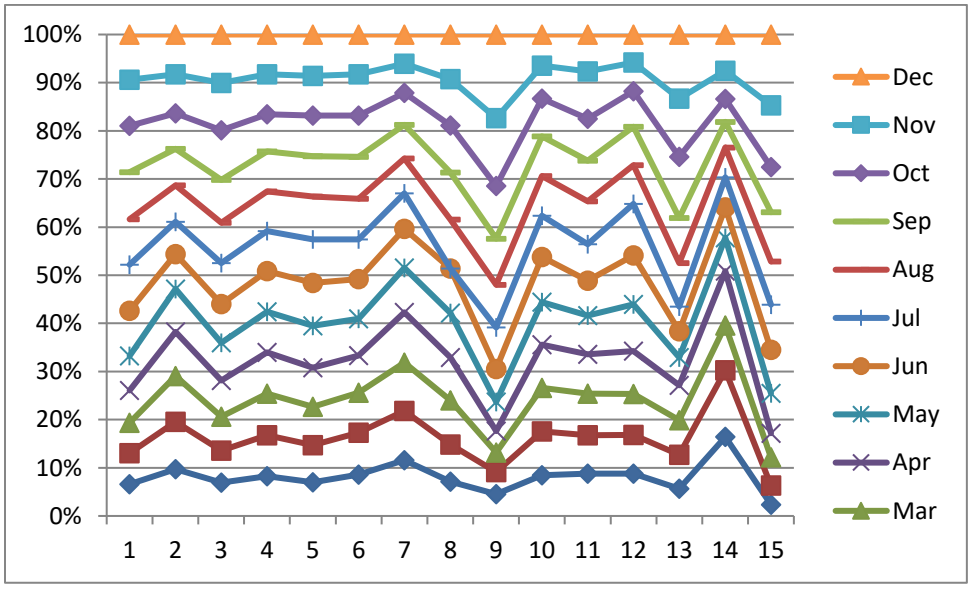
Source: Price and Labor statistics section, National Accounts and Economic statistics division, Stats SL.

4A. Annual CPI for clothing and footwear 2008 to 2022.



The year-on-year CPI for Clothing and Footwear data shows a trend that for this function, the CPI reached its highest for the period under review in 2017 at 27.00 percent, 2019 at 22.54 percent, 2018 at 15.61 percent, 2022 at 12.18 percent, 2020 at 11.98 percent, 2016 at 10.67 percent, and 2013 at 10.01 percent. The annual CPI for Clothing and Footwear was at an all-time low between 2008 to 2022, in 2009 at a paltry 4.53 percent relative to other years at that time.

4B. Monthly CPI for Clothing and footwear 2008 to 2022.



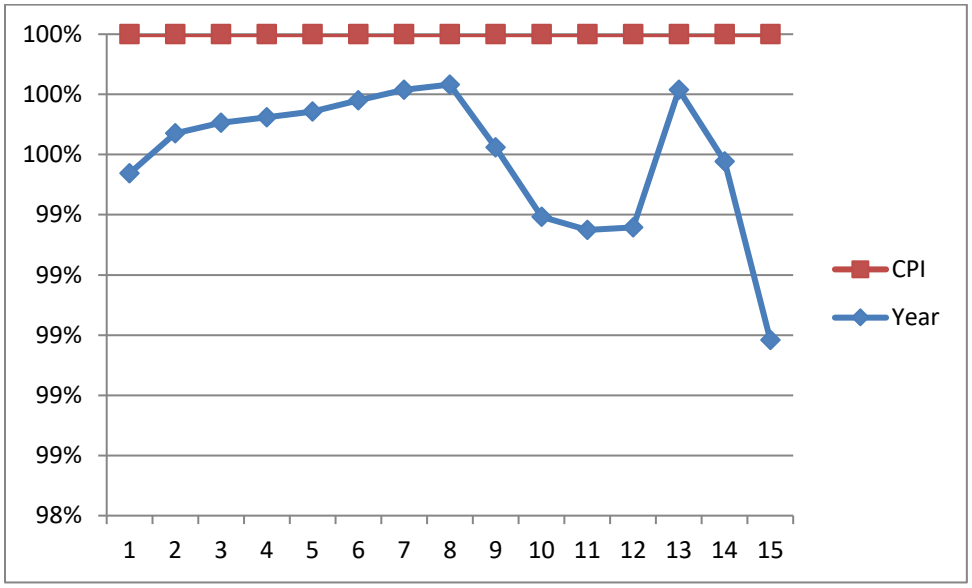
Monthly CPI for Clothing and Footwear reached its maximum for the given period in June 2017 at 30.22 percent, chased by the February 2017 figure at 29.49 percent, March 2017 at 29.28 percent, April 2017 at 29.26 percent, July 2019 at 28.98 percent, May 2017 at 28.62 percent, and July 2017 was at 27.94 percent. The monthly CPI for clothing and footwear was at its lowest in January 2022 standing at a meager 3.46 percent.

5. The CPI for Housing, water, electricity, gas and other fuels 2008 to 2022.

Month	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Jan	7.94	7.65	6.23	4.52	5.91	4.38	4.18	2.84	5.22	13.87	6.45	18.74	10.34	-3.95	19.86
Feb	7.78	7.7	6.15	4.55	5.95	4.36	4.24	2.95	5.45	14.35	6.72	17.18	11.54	-0.18	16.64
Mar	6.85	7.73	6.18	4.8	5.93	4.09	4.30	3.24	5.35	14.42	7.19	17.76	8.17	2.92	18.36
Apr	6.94	7.56	6.25	5.37	5.47	4.24	4.33	3.10	5.50	14.42	7.56	19.72	1.98	7.39	19.00
May	6.99	7.48	6.23	5.51	5.47	4.53	4.15	3.01	5.76	14.35	8.66	15.28	5.69	6.45	19.54
Jun	8.5	6.95	6.3	5.38	5.69	4.41	4.02	2.97	7.06	13.33	9.52	13.82	5.83	8.36	19.07
Jul	11.95	5.73	5.49	6.23	4.64	4.43	3.04	3.01	7.60	12.84	16.43	9.86	2.96	8.74	20.95
Aug	11.05	5.83	5.61	6.12	4.59	4.64	3.27	3.90	6.60	12.51	19.00	7.52	2.68	11.72	18.82
Sep	11.16	5.74	5.7	6.11	4.67	4.56	3.25	3.86	7.43	11.73	19.79	7.15	3.47	11.78	20.93
Oct	11.08	5.63	5.77	6.04	4.78	4.56	3.15	3.86	7.56	11.87	18.22	9.97	-0.40	14.16	22.44
Nov	11.01	5.76	5.71	5.96	4.77	4.56	3.30	3.85	12.57	7.87	20.07	9.11	-3.58	16.13	22.64
Dec	10.62	5.78	5.71	6.3	4.43	4.53	3.54	3.98	15.37	6.18	19.06	10.39	-3.95	19.47	30.89
Annual	9.32	6.63	5.94	5.57	5.19	4.44	3.73	3.38	7.62	12.31	13.22	13.04	3.73	8.58	20.76

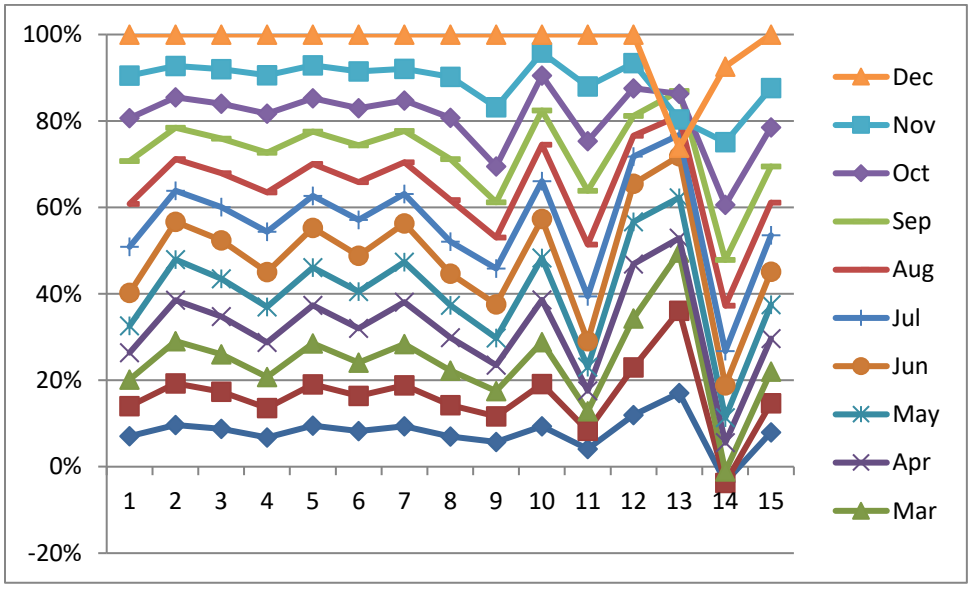
Source: Price and Labor statistics section, National Accounts and Economic statistics division, Stats SL.

5A. Annual CPI for Housing, water, electricity, gas and other fuels 2008 to 2022.



The annual CPI for Housing, water, electricity, gas and other fuels during the period being researched climaxed in 2022 at 20.76 percent, pursued by 2018 at 13.22 percent, 2018 at 13.04 percent, 2017 at 12.31 percent, 2008 at 9.32 percent, 2021 at 8.58 percent, and 2016 at 7.62 percent. In 2015, for the period 2008 to 2022, the CPI for Housing, water, electricity, gas and other fuels reached its lowest, at a meager 3.38 percent in relation to other years during the given time frame.

5B. Monthly CPI FOR Housing, water, electricity, gas and other fuels 2008 to 2022.



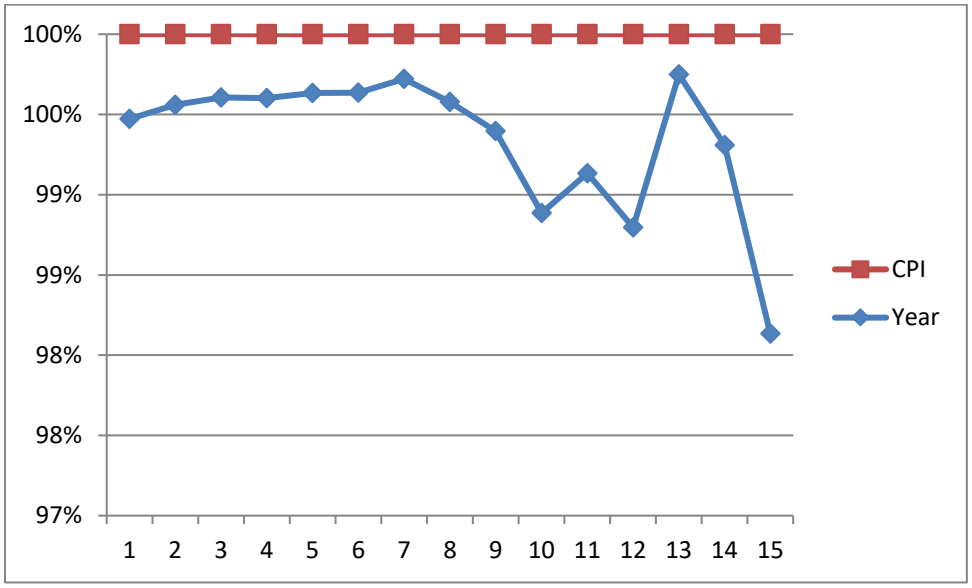
On a monthly basis, the CPI for housing, water, electricity, gas and other fuels peaked in December 2022 at 30.89 percent, trailed by the November 2022 figure which is at 22.64 percent, then October 2022 at 22.44 percent, July 2022 at 20.95 percent, September 2022 at 20.93 percent, January 2022 at 19.86 percent, September 2018 at 19.79 percent, and April 2019 at 19.72 percent. From 2008 to 2022 the CPI for Housing, water, electricity, gas and other fuels was at its lowest in January 2015 standing at 2.84 percent.

6. The CPI for Furnishing, household equipment and maintenance 2008 to 2022.

Month	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Jan	9.05	8.44	8.44	8.3	7.20	7.28	6.10	5.31	10.76	21.41	15.54	18.03	18.19	6.16	32.68
Feb	8.95	8.53	8.91	7.91	7.22	7.34	6.00	6.63	9.57	24.32	14.76	22.02	8.30	13.15	30.06
Mar	8.87	8.28	8.99	7.86	7.33	7.33	5.62	8.11	8.78	24.36	17.01	20.91	8.29	11.64	28.75
Apr	8.99	8.25	8.88	7.92	7.84	7.93	4.59	8.64	8.38	26.03	15.72	23.13	7.67	10.75	33.04
May	9.43	7.99	8.98	8.13	7.66	7.74	4.52	9.10	9.71	23.90	16.45	32.05	0.30	10.54	35.29
Jun	10.44	9.23	7.87	8.14	7.45	7.73	4.64	8.95	10.68	24.50	16.61	33.95	-1.18	11.11	35.28
Jul	12.36	8.79	6.99	8.43	7.14	7.71	4.61	8.41	12.31	23.49	18.36	32.37	-1.31	15.82	34.40
Aug	11.92	9.15	7.09	8.36	7.12	7.39	6.31	9.50	12.06	21.95	23.51	21.32	3.07	14.44	41.51
Sep	12.09	8.85	7.36	8.1	7.11	7.55	6.32	9.39	12.56	22.85	19.50	25.51	2.70	16.91	38.67
Oct	12.06	8.74	8.28	7.57	7.46	7.00	6.27	9.25	14.21	22.22	19.02	25.33	2.27	17.60	45.87
Nov	12	10.1	6.94	7.8	7.72	6.59	6.33	9.38	17.49	19.67	19.96	18.28	6.09	20.18	51.74
Dec	11.78	10.18	6.89	7.86	7.64	6.71	6.35	9.76	20.62	18.06	15.24	22.24	6.60	20.53	54.10
Annual	10.66	8.88	7.97	8.03	7.41	7.36	5.64	8.54	12.26	22.73	17.64	24.60	5.08	14.07	38.45

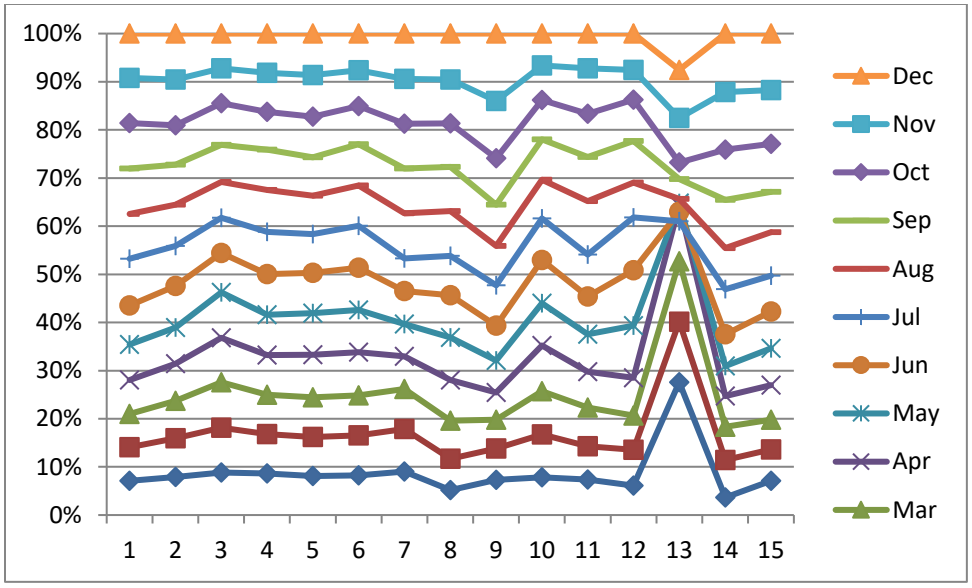
Source: Price and Labor statistics section, National Accounts and Economic statistics division, Stats SL.

6A. Annual CPI for Furnishing, household equipment and maintenance 2008 to 2022.



From the graph it can be seen that the Annual CPI for Furnishing, household equipment and maintenance from 2008 to 2022 stood at 38.45 percent in 2022, followed by 24.60 percent in 2019, 22.73 percent in 2017, 17.64 percent in 2018, 14.07 percent in 2012, 12.26 percent in 2016, and 10.66 percent in 2008. In 2020, the annual CPI for furnishing, household equipment and maintenance hit rock bottom at 5.08 percent.

6B. Monthly CPI Furnishing, household equipment and maintenance 2008 to 2022.



With regards the monthly figures in relation to the CPI for Furnishing, household equipment and maintenance reached its greatest height for the period under review in December 2022 at

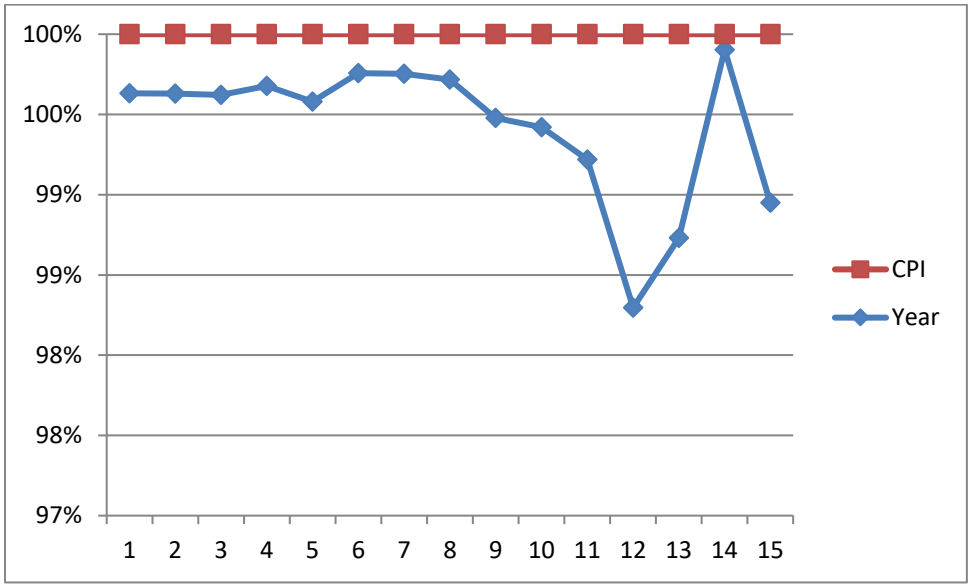
54.10 percent, seconded by the November 2022 figure at 51.74 percent, then October 2022 at 45.87 percent, August 2022 at 41.51 percent, September 2022 at 38.57 percent, May 2022 at 35.29 percent, and June 2022 at 35.28 percent. The May 2014 figure is the least recorded of the monthly CPI for furnishing, household equipment and maintenance reaching only 4.52 percent, in the Sierra Leone CPI figures, reached its least level.

7. The CPI for Health 2008 to 2022.

Month	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Jan	5.18	8.69	5.71	7.23	9.93	5.06	4.45	4.52	8.04	12.39	12.27	22.91	35.46	8.85	12.93
Feb	5.44	8.14	5.79	7.23	9.90	5.18	4.69	4.19	8.76	13.15	12.69	21.24	46.21	-2.80	18.91
Mar	6.15	7.41	6.07	7.69	9.31	5.02	4.72	5.31	7.93	12.93	14.76	20.53	48.46	-1.86	18.90
Apr	5.16	8.09	6.93	6.74	8.79	5.33	4.82	4.74	9.63	12.89	15.32	16.07	52.31	-3.30	18.10
May	7.66	7.07	5.99	6.38	9.52	4.41	4.85	5.34	10.66	11.52	16.11	32.44	33.61	-3.65	20.24
Jun	9.27	6.63	6.14	6.62	9.25	4.44	5.17	5.26	9.67	13.28	16.64	36.12	21.78	0.21	22.88
Jul	9.16	7.74	7.68	5.68	7.79	5.76	3.74	5.05	11.13	12.76	17.40	37.61	19.03	0.86	19.54
Aug	8.97	7.99	9.42	5.09	7.10	5.14	5.21	6.69	8.71	12.62	15.58	53.74	9.56	0.66	21.22
Sep	8.14	6.21	9.3	6.87	7.53	4.96	5.38	6.61	11.32	10.99	15.43	46.24	13.75	3.84	23.79
Oct	8.1	6.75	8.75	7.2	7.24	5.00	5.46	6.38	14.11	9.08	15.60	45.62	13.13	4.31	25.70
Nov	7.9	7.49	9.88	5.68	7.55	4.45	5.55	6.70	13.81	9.71	16.68	47.57	10.76	3.89	28.54
Dec	8.13	7.27	10.15	5.42	7.91	4.12	5.60	7.97	13.12	10.08	22.19	39.95	7.44	12.47	26.98
Annual	7.44	7.46	7.65	6.49	8.49	4.91	4.97	5.73	10.57	11.78	15.89	35.00	25.96	1.96	21.48

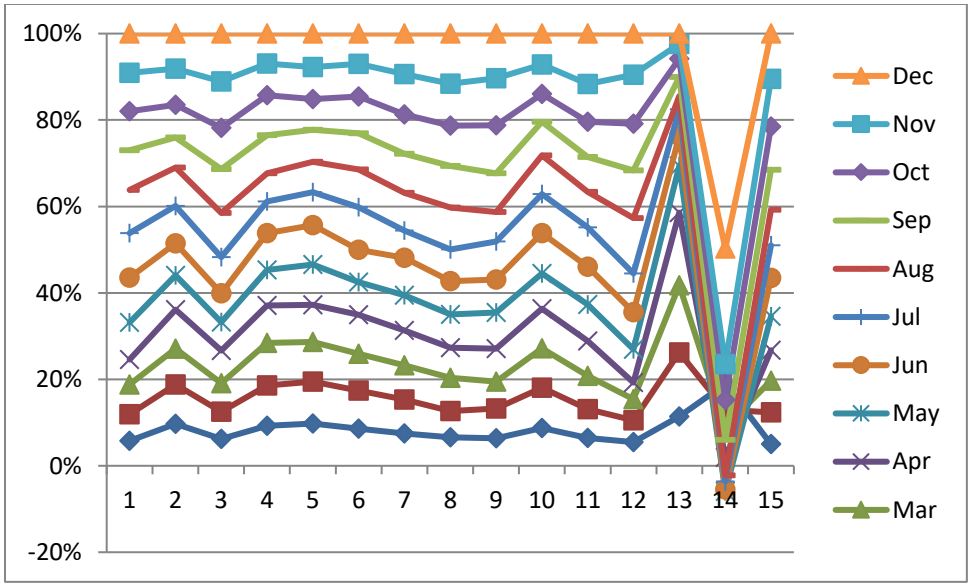
Source: Price and Labor statistics section, National Accounts and Economic statistics division, Stats SL.

7A. Annual CPI for Health 2008 to 2022.



As far as the annual CPI for Health is concerned, it assumed its highest level in 2019 at 35.0 percent, followed by the 2020 figure which is at 25.96 percent, then the 2022 figure at 21.48 percent, 2018 at 15.89 percent, 2017 at 11.78 percent, 2016 at 10.57 percent, and 2012 at 8.49 percent. For the period under review the annual CPI for Health is at its lowest level in 2021 at 1.96 percent.

7B. Monthly CPI for Health 2008 to 2022.



The monthly CPI figures for health reveals that August 2019 at 53.74 percent is the highest, followed by March 2020 at 48.46 percent, November 2019 at 47.57 percent, September 2019 at

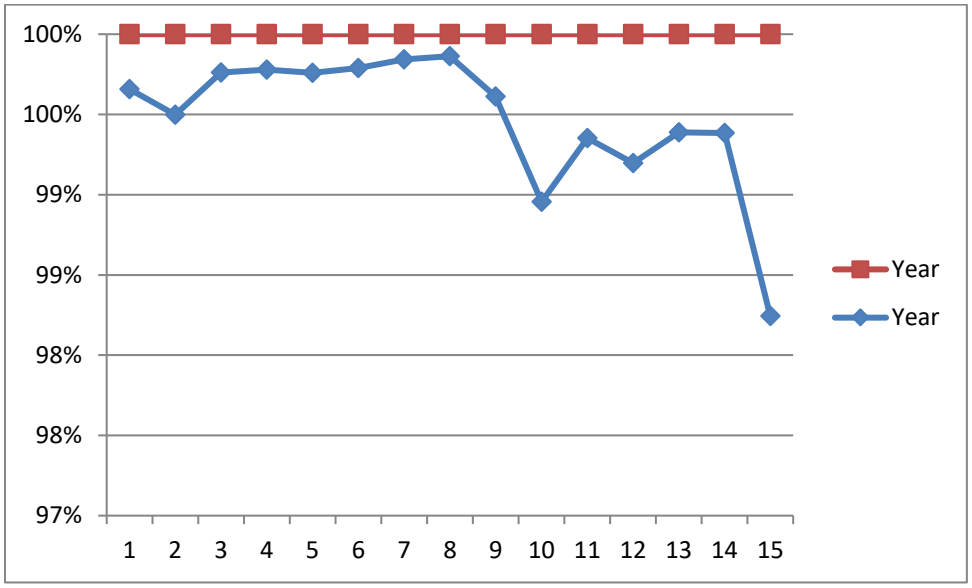
46.24 percent, February 2020 at 46.21 percent, April 2020 at 52.31 percent, and October 2019 at 45.62 percent. The July 2014 CPI for Health figure at 3.74 percent is the lowest recorded for the period under study.

8. The CPI for Transport 2008 to 2022.

Month	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Jan	5.54	9.99	5.32	4.12	5.74	3.74	3.86	1.05	5.40	19.81	10.38	18.87	17.78	1.33	21.42
Feb	5.68	9.84	5.32	4.12	5.83	3.74	4.09	0.56	5.68	20.28	10.19	17.88	19.03	4.86	15.95
Mar	5.68	9.84	5.35	4.18	5.77	3.77	3.33	2.36	4.82	21.62	9.45	17.31	17.50	6.22	35.75
Apr	5.68	9.91	5.23	4.27	5.74	3.90	3.30	1.94	5.37	23.97	7.67	18.78	14.10	8.01	37.51
May	7.06	9.78	4.86	4.41	4.94	4.07	2.96	1.64	8.42	23.29	6.19	20.74	11.86	6.87	37.52
Jun	7.02	10.18	4.48	4.46	4.85	4.07	3.06	1.94	8.54	22.93	6.58	21.00	15.01	3.67	52.20
Jul	7.13	10.13	4.81	4.3	4.68	4.02	3.18	2.11	8.10	23.42	14.68	18.04	10.59	10.85	50.87
Aug	7.17	10.2	4.78	4.27	4.67	4.05	4.17	3.32	6.17	23.22	16.69	13.09	12.69	20.19	25.16
Sep	7.91	10.55	4.19	4.88	3.86	4.72	3.03	3.52	6.52	23.78	17.90	13.87	9.02	20.88	29.93
Oct	7.95	10.59	4.25	4.82	4.00	4.84	2.77	4.35	6.54	23.30	17.71	13.57	7.43	22.30	42.13
Nov	8.16	10.37	4.4	4.87	3.91	5.10	2.19	4.57	13.98	15.41	19.26	11.72	7.38	23.27	40.55
Dec	8.09	10.37	4.64	4.52	4.10	5.25	1.84	5.85	14.50	14.43	21.31	11.47	6.64	21.82	44.89
Annual	6.92	10.15	4.80	4.44	4.84	4.27	3.15	2.77	7.84	21.29	13.17	16.36	12.42	12.52	36.16

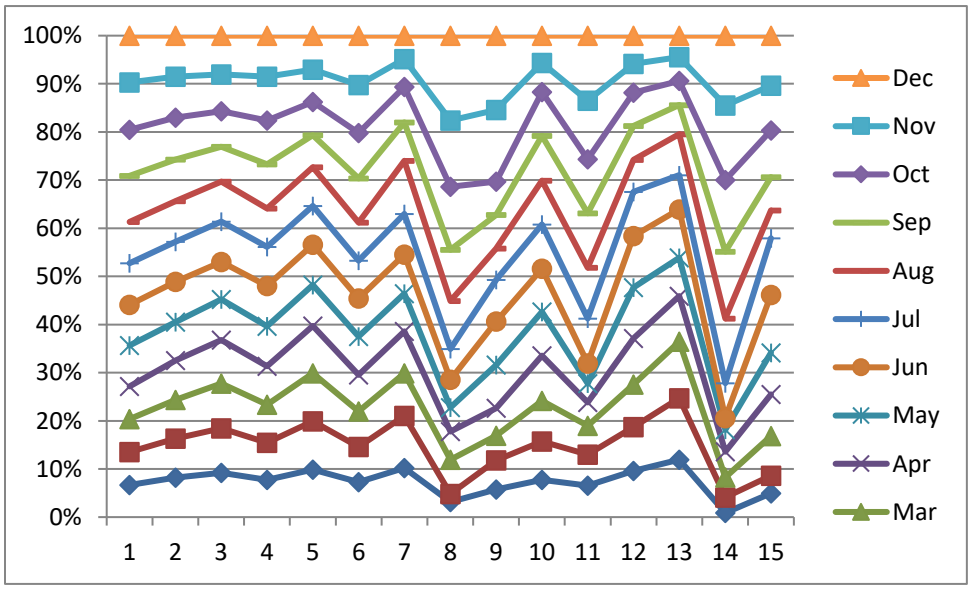
Source: Price and Labor statistics section, National Accounts and Economic statistics division, Stats SL.

8A. Annual CPI for Transport 2008 to 2022.



The year-on-year CPI for Transport figures shows that transportation cost was at its highest in 2022 at 36.16 percent, followed by 2017 at 21.29 percent, 2019 at 16.36 percent, 2021 at 12.52 percent, 2020 at 12.42 percent, 2018 at 13.17 percent, and 2009 at 10.15 percent. Transport prices were most stable in 2015 at 2.77 percent for the specified period of 2008 to 2022.

8B. Monthly CPI for Transport 2008 to 2022.



On a monthly basis CPI for transport was at skyrocketed prices in June 2022 at 52.20 percent, accompanied by the July 2022 prices at 50.87 percent, December 2022 at 44.89 percent, October 2022 at 42.13 percent, November 2022 at 40.55 percent, May 2022 at 37.52 percent,

and April 2022 at 37.51 percent. February 2015 transport prices at 0.56 percent were the lowest for the period under review, at a time when fuel pump prices were still being subsidized by government.

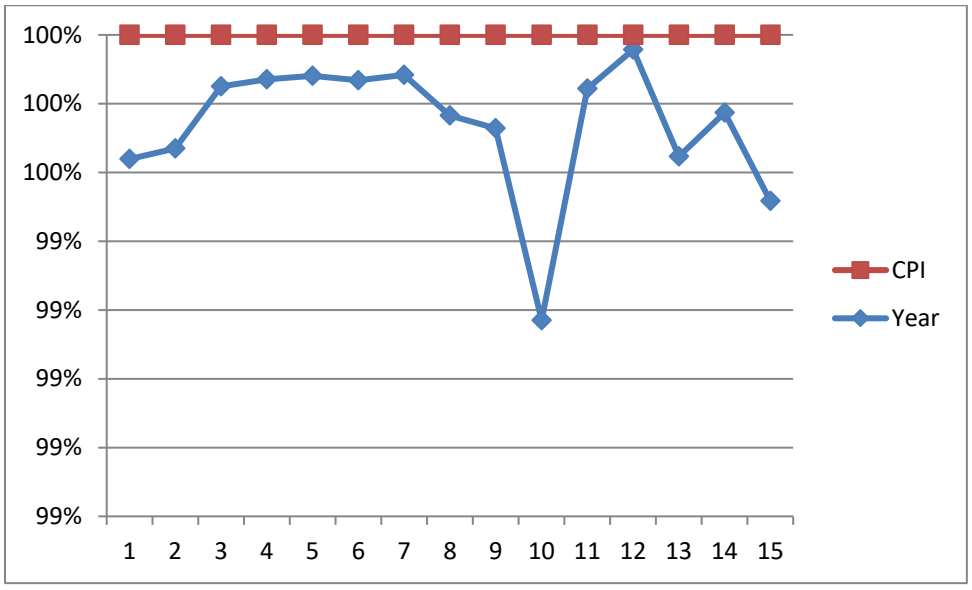
9. The CPI for Communication 2008 to 2022.

Month	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Jan	8.06	5.09	4.9	2.61	2.39	2.28	2.66	3.16	4.12	14.40	11.45	-12.39	7.22	16.29	6.96
Feb	8.06	5.09	4.9	2.61	2.39	2.28	2.66	3.16	4.30	15.38	13.52	-5.95	2.00	10.91	7.47
Mar	8.06	5.09	4.9	2.61	2.39	2.28	2.66	4.62	2.87	15.42	13.77	-7.05	8.59	3.25	9.90
Apr	8.06	7.69	2.36	2.61	2.37	2.78	2.17	4.63	2.96	17.38	12.41	-7.52	8.52	3.24	11.10
May	8.08	7.67	2.36	2.61	2.40	2.75	2.17	4.63	2.98	18.09	12.09	2.21	-1.30	2.37	10.51
Jun	8.08	7.67	2.38	2.59	2.40	2.75	2.17	4.63	4.38	17.86	11.38	2.58	-1.28	1.34	11.83
Jul	5.77	7.67	2.38	2.59	2.40	2.78	2.14	4.63	5.47	17.39	11.51	-5.63	5.55	2.36	11.52
Aug	5.77	7.67	2.38	2.59	2.40	2.78	2.14	5.56	4.62	17.72	-8.45	18.67	4.40	-0.09	9.94
Sep	5.77	7.67	2.38	2.59	2.40	2.78	2.15	5.54	5.36	19.19	-8.81	6.45	12.60	1.66	11.60
Oct	5.77	7.67	2.38	2.59	2.40	2.80	2.14	5.64	5.78	19.58	-9.13	5.96	11.72	2.48	11.99
Nov	7.93	5.52	2.4	2.57	2.40	2.80	2.14	5.72	9.38	16.82	-9.54	5.28	12.05	3.96	11.02
Dec	7.88	5.42	2.4	2.57	2.40	2.80	3.05	4.78	13.61	13.20	-12.	7.88	15.86	7.17	3.96

											30				
Annual	7.27	6.66	3.01	2.60	2.40	2.66	2.35	4.73	5.49	16.88	3.16	0.87	7.16	4.58	9.82

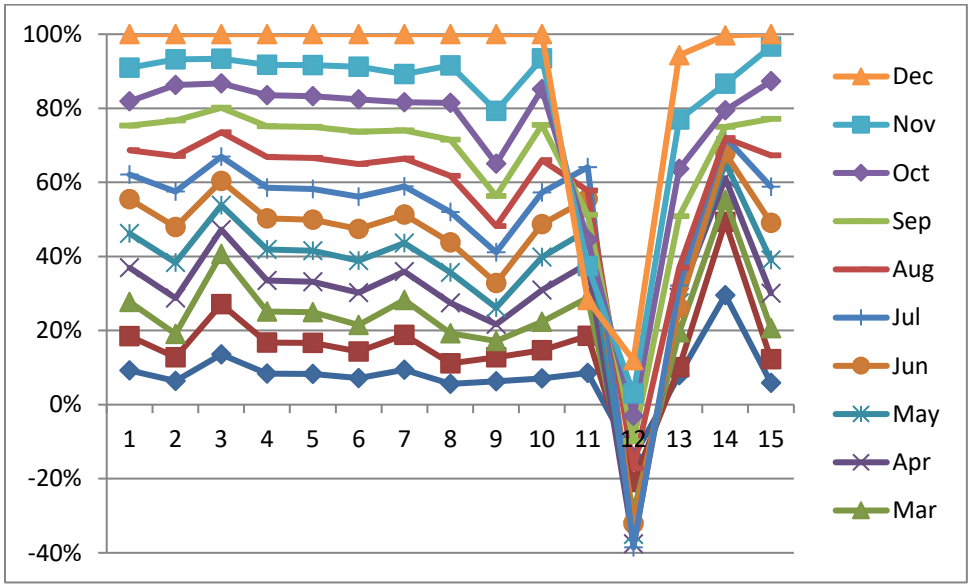
Source: Price and Labor statistics section, National Accounts and Economic statistics division, Stats SL.

9A. Annual CPI for Communication 2008 to 2022.



Annual CPI for Communication figures reveal that the cost of communication was highest in 2017 at 16.88 percent, next is 2022 at 9.82 percent, 2008 at 7.27 percent, 2020 at 7.16 percent, 2009 at 6.66 percent, 2016 at 5.49 percent, and 2015 at 4.73 percent. 2014 figures at 2.35 percent was arguably the best year for spending on communication.

9B. Monthly CPI for Communication 2008 to 2022.



Monthly CPI figures for communication stood tallest in October 2017 at 19.58 percent, seconded by September 2017 at 19.19 percent, May 2017 at 18.09 percent, June 2017 at 17.86 percent, August 2017 at 17.72 percent, July 2017 at 17.39 percent, and 17.38 percent. The July 2014 and August 2014 figures were the lowest at 2.14 percent respectively.

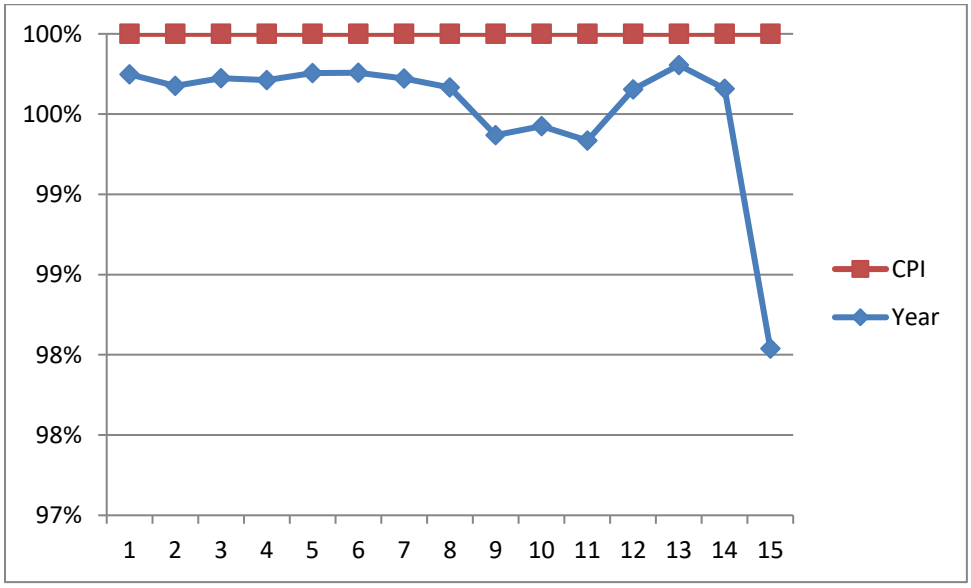
10. The CPI for Recreation and culture 2008 to 2022.

Month	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Jan	2.78	6.38	6.23	6.29	4.68	4.38	5.81	4.62	9.08	16.34	10.32	12.67	-0.17	4.45	30.42
Feb	2.87	6.59	5.98	6.56	4.57	4.25	5.71	5.01	9.71	15.48	11.33	19.69	-6.78	4.63	32.67
Mar	2.87	6.53	5.96	6.7	4.92	4.11	6.19	5.80	12.10	11.79	13.26	12.68	0.06	1.45	35.74
Apr	2.87	7.14	5.36	7.08	4.55	4.47	5.94	6.99	11.37	11.55	14.12	13.80	-1.11	0.95	37.50
May	3.56	7.03	4.9	6.56	5.52	4.59	5.53	7.12	11.72	11.23	14.65	8.50	2.89	1.37	40.95
Jun	4.25	6.5	5.06	6.32	5.42	5.04	5.25	7.13	12.37	11.99	13.87	5.19	5.94	1.55	44.40
Jul	6.09	6.45	5.03	5.77	5.18	5.18	4.84	6.63	13.75	10.67	14.38	5.65	6.41	1.42	50.25

Aug	7.16	5.77	6.07	4.55	5.15	5.15	5.55	7.58	12.85	10.12	14.09	3.09	9.40	2.38	50.27
Sep	7.11	6.38	5.31	5.09	5.02	4.85	5.88	7.51	13.14	10.18	16.89	-0.49	10.37	6.29	45.33
Oct	7.24	6.31	5.28	4.91	5.00	5.59	5.34	7.66	15.70	9.09	14.19	0.30	10.10	11.64	43.97
Nov	7.18	6.58	5.14	5.53	4.65	5.39	5.87	7.21	15.71	10.77	14.90	0.28	5.41	19.76	39.45
Dec	7.21	6.58	6.55	4.51	4.31	5.69	5.54	7.80	16.36	10.97	10.01	3.05	4.73	27.50	34.55
Annual	5.10	6.52	5.57	5.82	4.91	4.89	5.62	6.76	12.82	11.68	13.50	7.03	3.94	6.95	40.46

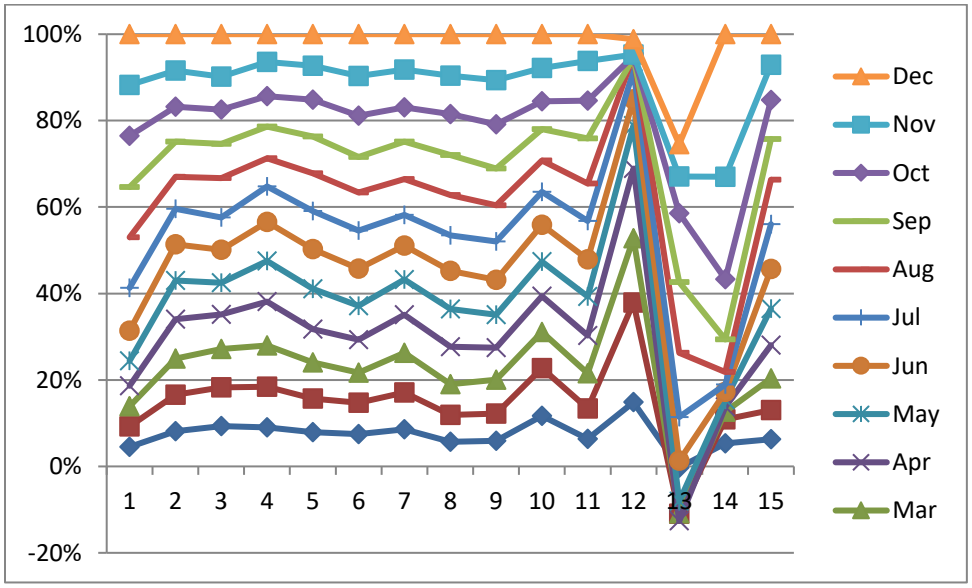
Source: Price and Labor statistics section, National Accounts and Economic statistics division, Stats SL.

10A. Annual CPI for Recreation and culture 2008 to 2022.



The annual CPI for recreation figures shows that in 2022 recreation and culture became most expensive at 40.46 percent, 2018 followed at 13.50 percent, then 2016 at 12.82 percent, 2017 at 11.68 percent, 2019 at 7.03 percent, 2021 at 6.95 percent, and 2015 at 6.76 percent. The most favorable time to spend in recreation and culture for the period in consideration is 2020 when its CPI stood at just 3.94 percent.

10B. Monthly CPI for Recreation and culture 2008 to 2022.



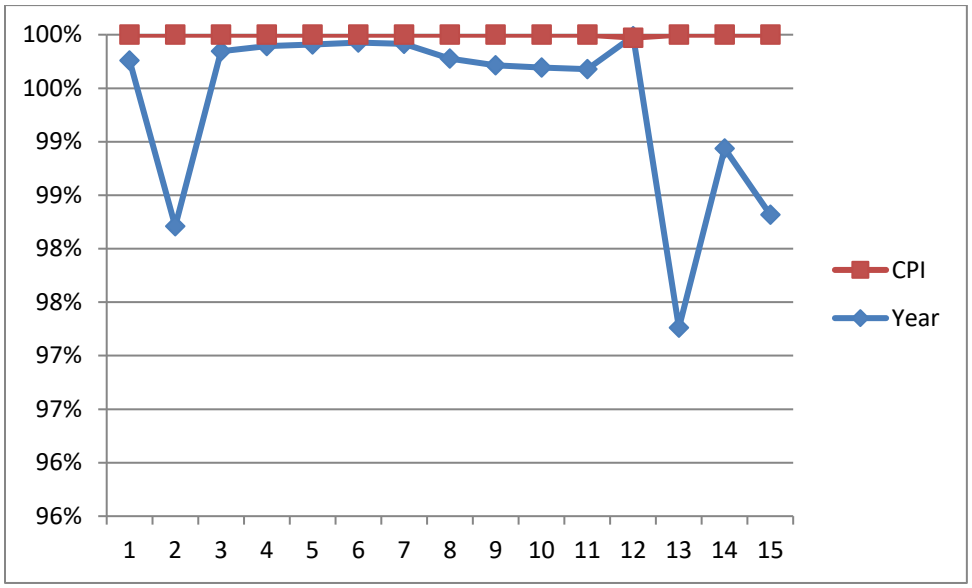
Monthly CPI for recreation and culture figures of August 2022 at 50.27 percent are the greatest, closely followed by July 2022 at 50.25 percent, September 2022 at 45.33 percent, June 2022 at 44.40 percent, October 2022 at 43.97 percent, November 2022 at 39.45 percent, and April 2022 at 37.50 percent. Interestingly, Jan 2008, the first year under consideration in the research comes out as the best year to spend on recreation and culture at 2.78 percent.

11. The CPI for Education 2008 to 2022.

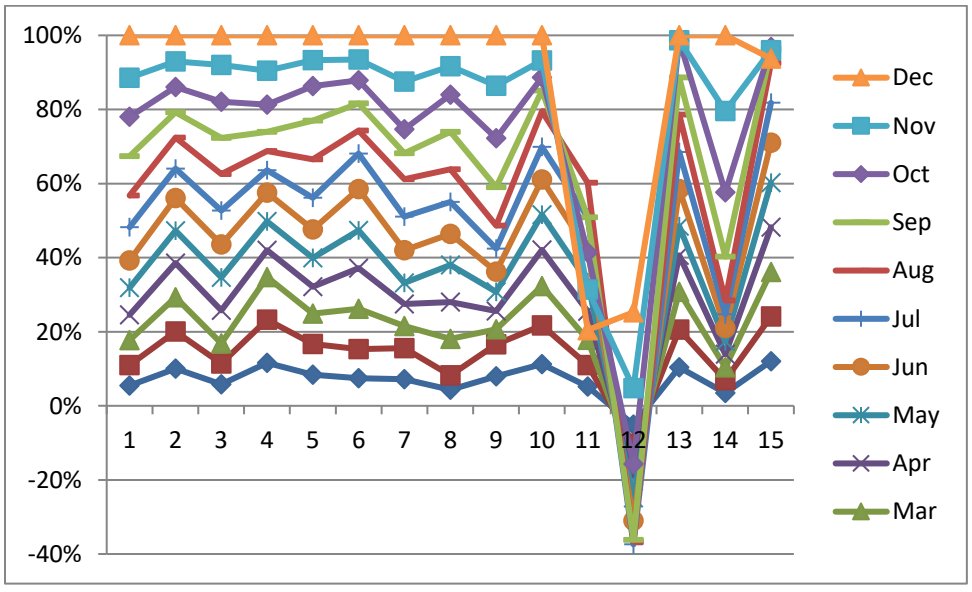
Month	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Jan	3.15	7.97	2.18	2.99	1.85	1.31	1.47	2.36	5.48	8.34	7.55	-17.81	70.75	9.05	53.35
Feb	3.22	7.97	2.11	3.02	1.82	1.37	1.71	2.09	6.00	7.81	8.48	-18.07	69.79	9.05	53.35
Mar	3.91	7.36	2.08	2.96	1.79	1.91	1.22	5.33	2.77	7.88	10.03	-18.10	69.93	9.05	53.35
Apr	3.95	7.32	3.35	1.89	1.60	1.91	1.22	5.36	3.44	7.26	11.23	-12.07	67.32	9.05	53.35
May	4.28	6.98	3.35	2.01	1.69	1.79	1.16	5.41	3.57	7.03	11.61	-20.84	53.41	9.05	53.35
Jun	4.24	6.98	3.35	2.01	1.69	1.94	1.81	4.55	3.77	7.10	12.48	-21.38	68.69	9.63	47.67
Jul	5.25	6.37	3.46	1.56	1.88	1.69	1.84	4.67	4.29	6.52	13.15	-22.22	68.69	9.63	47.67
Aug	4.96	6.62	3.69	1.34	2.28	1.08	2.08	4.75	4.29	7.10	13.64	2.19	68.69	9.63	47.67
Sep	6.15	5.42	3.69	1.34	2.28	1.29	1.43	5.45	7.17	4.23	-13.71	2.19	68.69	30.82	15.28
Oct	6.15	5.42	3.69	1.9	2.05	1.08	1.31	5.45	9.11	2.60	-13.90	71.35	68.69	45.25	3.82
Nov	6.12	5.53	3.72	2.37	1.55	0.99	2.64	4.14	9.78	3.44	-14.65	71.35	0.00	57.22	-4.08
Dec	6.65	5.59	3.02	2.46	1.46	1.14	2.55	4.51	9.40	5.01	-15.98	71.35	9.05	53.35	-9.82
Annual	4.84	6.63	3.14	2.15	1.83	1.46	1.70	4.51	5.76	6.19	6.49	-0.28	56.89	21.73	34.58

Source: Price and Labor statistics section, National Accounts and Economic statistics division, Stats SL.

11A. Annual CPI for Education 2008 to 2022.



Annual CPI for education figures cascades 2020 at 56.89 percent which is the most expensive year in education prices, 2022 at 34.58 percent, 2021 at 21.73 percent, 2009 a 6.63 percent, 2018 at 6.49 percent, 2017 at 6.19 percent, and 2016 at 5.76 percent. The cost of education expenses was at an all- time low in 2019 at -0.28 percent, perhaps due to the SLPP government's introduction of the Free Quality School Education (FQSE) project, that makes tuition fees free for primary, junior, and senior secondary school education.**11B. Monthly CPI for Education 2008 to 2022.**



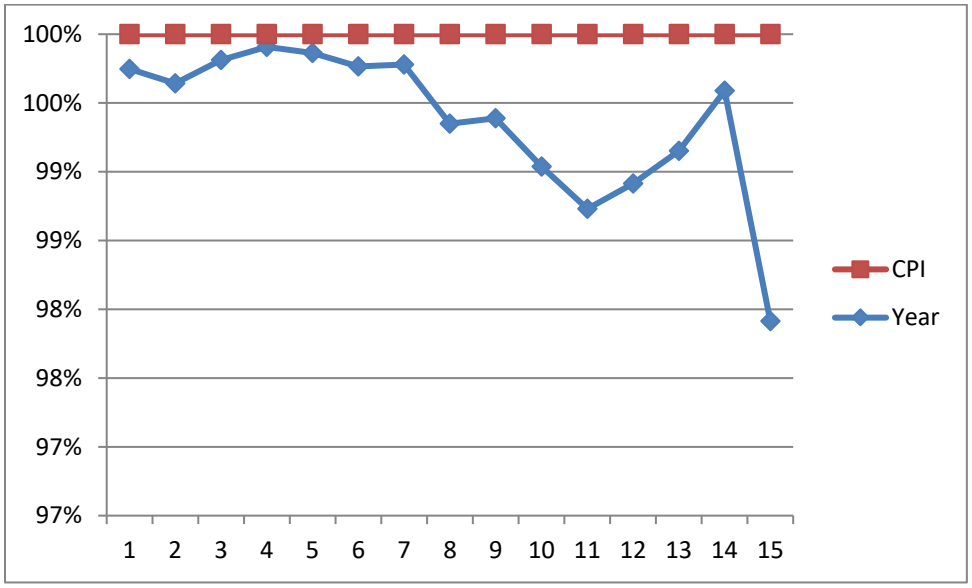
Monthly CPI for education figures highlights January 2020 to be the highest level at 70.75 percent, October; November; and December 2019 all tie second at 71.35 percent. To be followed by March 2020 at 69.93 percent, February 2020 at 69.79 percent, chased by June; July; August; September; and October 2020 all jointly at 68.69 percent. In July 2019, CPI for Education assumed its lowest value at -22.22 percent, due to the implementation by government of the FQSE project.

12. The CPI for Restaurants and hotels 2008 to 2022.

Month	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Jan	4.29	4.91	7.09	1.85	2.36	3.40	3.36	9.37	13.58	19.13	17.42	30.50	21.30	-1.40	36.62
Feb	4.39	5.44	6.92	1.49	2.28	4.65	2.53	9.12	16.59	15.92	20.49	27.41	20.07	1.62	33.78
Mar	4.52	5.25	6.92	1.57	2.24	5.25	2.44	13.45	12.23	16.59	22.19	26.95	20.15	-1.20	39.24
Apr	4.52	5.43	6.78	1.73	2.08	5.14	2.51	13.70	12.79	17.02	23.30	23.61	22.53	-0.45	41.45
May	6.05	8.5	2.45	1.65	2.47	5.04	2.19	14.48	11.88	19.03	23.34	19.34	27.89	2.65	40.19
Jun	5.81	8.37	2.49	1.57	2.59	5.08	2.69	14.17	12.10	19.27	25.05	17.80	28.64	1.69	46.55
Jul	5.9	8.27	2.49	1.57	2.70	5.27	2.64	14.58	12.15	19.26	27.48	20.22	23.13	2.71	51.63
Aug	6.13	7.82	2.7	1.77	2.81	5.40	5.48	14.97	8.54	21.38	29.59	15.22	22.89	3.96	53.97
Sep	6.32	8.24	2.12	2.04	3.08	4.81	6.05	14.73	8.63	23.16	26.15	30.59	5.43	17.12	42.87
Oct	4.6	7.85	2	1.84	3.58	4.87	6.88	13.44	9.83	23.91	33.40	20.93	5.36	18.60	48.80
Nov	4.6	7.85	2.12	2.35	3.68	4.10	7.80	13.36	13.44	20.42	25.92	23.34	4.95	24.30	43.94
Dec	4.04	8.84	1.23	2.86	3.20	3.47	8.66	12.76	17.25	20.02	37.21	10.13	4.88	30.45	41.74
Annual	5.10	7.23	3.78	1.86	2.76	4.71	4.44	13.18	12.42	19.59	25.96	22.17	17.27	8.34	43.07

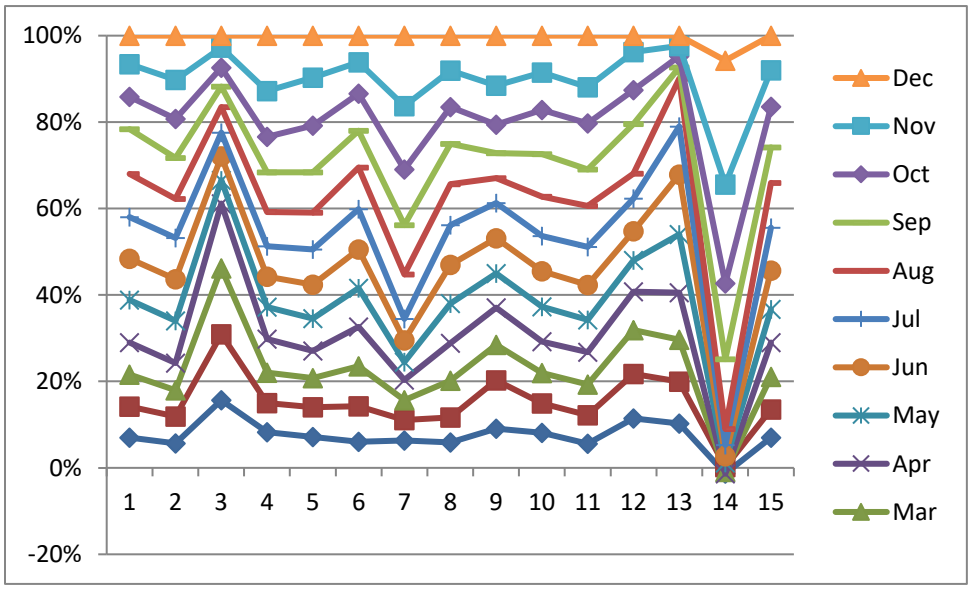
Source: Price and Labor statistics section, National Accounts and Economic statistics division, Stats SL

12A. Annual CPI for Restaurants and hotels 2008 to 2022.



On an annual basis, the CPI for restaurants and hotels was at its highest in 2022 at 43.07 percent, 2018 at 25.96 percent, 2019 at 22.17 percent, 2017 at 19.59 percent, 2020 at 17.27 percent, 2015 at 13.18 percent, and 2016 at 12.2 percent. Annual prices for restaurants and hotels were most stable in 2011 at 1.86 percent.

12B. Monthly CPI for Restaurants and hotels 2008 to 2022.



On a monthly basis, the figures reveal that the CPI for Restaurants and Hotels was highest in August 2022 at 53.97 percent, accompanied by July 2022 at 51.63 percent, October 2022 at 48.80 percent, June 2022 at 46.55 percent, November 2022 at 43.94 percent, September 2022

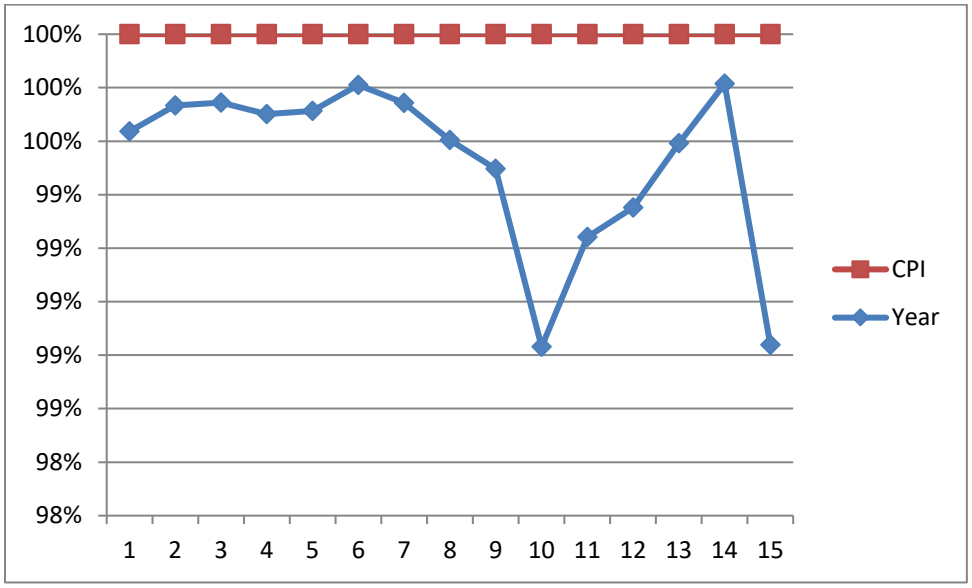
at 42.87 percent, and December 2022 at 41.74 percent. The monthly CPI for Restaurants and Hotels was at its lowest in February 2011 at 1.49 percent during the period in question.

13. The CPI for Miscellaneous goods and services 2008 to 2022.

Month	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Jan	3.02	8.82	4.3	5.79	6.61	4.07	3.83	6.25	8.92	22.54	16.20	12.10	10.77	4.57	11.56
Feb	3.59	8.74	3.99	6.61	5.69	4.19	4.56	5.83	8.96	23.93	15.82	12.70	7.17	7.68	11.35
Mar	4.42	7.86	4.31	6.22	6.42	3.53	4.78	7.60	7.43	24.10	17.02	11.71	10.74	3.27	13.54
Apr	6.35	5.72	4.64	6.48	6.00	3.47	4.89	8.33	7.17	24.32	18.21	13.50	8.33	1.30	17.48
May	7.69	4.38	5.03	5.83	6.47	3.59	4.97	8.55	7.58	24.44	18.40	15.71	6.44	0.51	19.72
Jun	8.46	4.19	4.85	5.7	6.57	3.96	4.73	8.66	7.56	25.23	18.73	13.25	8.87	-3.38	27.89
Jul	8.67	4.42	5.23	5.25	6.61	3.66	5.07	8.27	8.38	25.17	17.96	16.44	2.92	1.13	29.24
Aug	8.71	4.6	5.46	6.09	5.30	3.86	5.71	8.55	7.31	27.83	13.48	11.49	11.94	-0.60	31.28
Sep	9.13	4.15	5.75	6.52	4.95	3.72	5.55	8.61	7.45	28.52	16.97	11.38	8.01	4.79	24.97
Oct	8.98	4.33	5.76	6.31	4.99	4.06	5.57	8.50	13.37	22.64	11.77	15.62	8.90	5.72	27.77
Nov	9.48	3.41	6.27	5.96	4.69	4.11	6.02	8.63	17.13	20.32	14.62	8.56	8.65	9.14	31.94
Dec	9.46	3.76	6.27	5.46	5.31	3.74	6.52	8.32	21.22	17.22	6.00	15.66	6.42	10.82	38.39
Annual	7.33	5.37	5.16	6.02	5.80	3.83	5.18	8.01	10.21	23.86	15.43	13.18	8.26	3.75	23.76

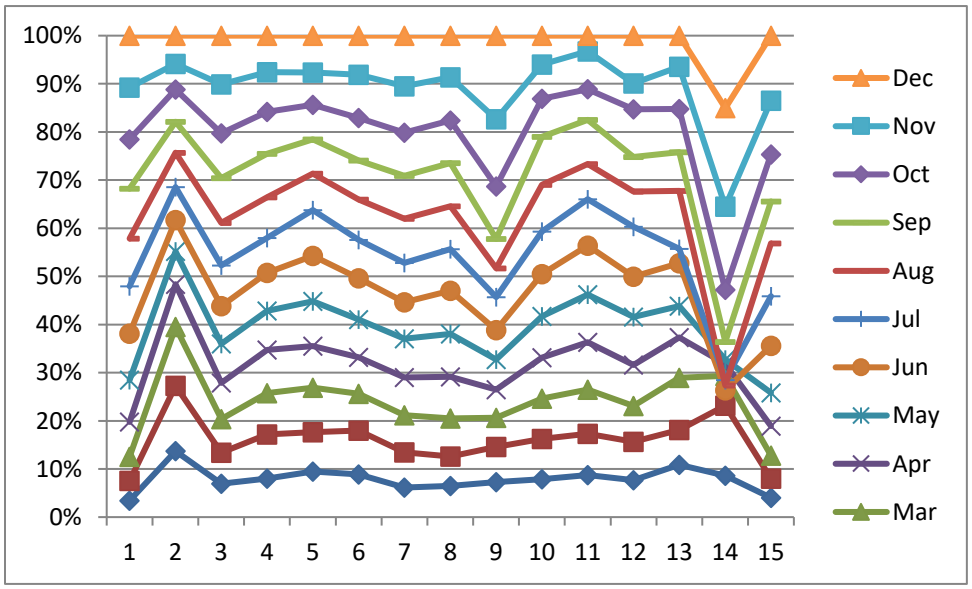
Source: Price and Labor statistics section, National Accounts and Economic statistics division, Stats SL.

13A. Annual CPI for Miscellaneous goods and services 2008 to 2022.



Annual CPI for Miscellaneous goods and services climaxed in 2017 at 23.86 percent, followed by 2022 at 23.76 percent, 2018 at 15.43 percent, 2019 at 13.18 percent, 2016 at 10.21 percent, 2020 at 8.26 percent, and 2015 at 8.01 percent. It was best to spend on Miscellaneous goods and services in 2021 when its CPI stood at 3.75 percent.

13B.Monthly CPI for Miscellaneous goods and services 2008 to 2022.



Monthly CPI for Miscellaneous Goods and Services shot up the most in December 2022 at 38.39 percent, chased by November 2022 at 31.94 percent, August 2021 at 31.28 percent, July 2022 at 29.24 percent, September 2017 at 28.52 percent, June 2022 at 27.89 percent, and August

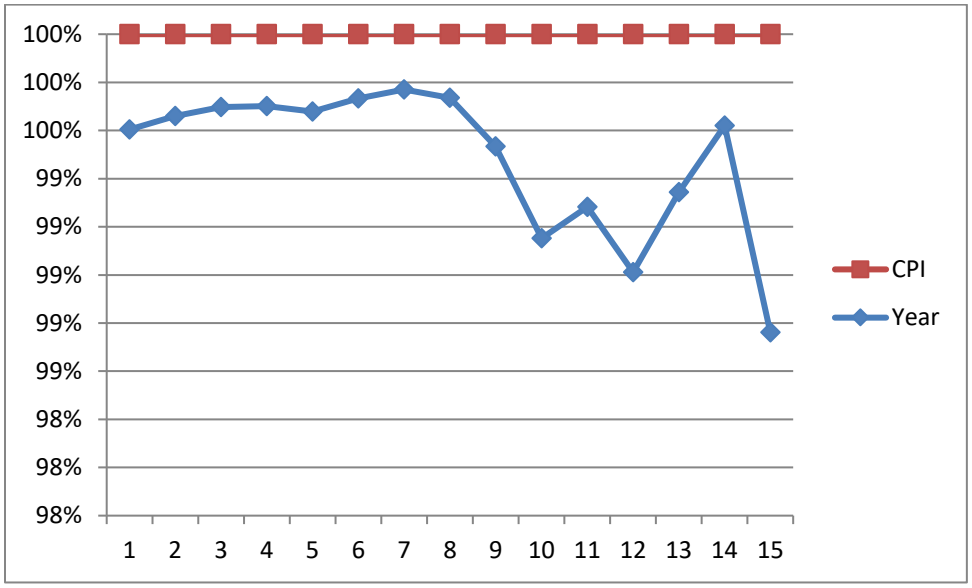
2017 at 27.83 percent. For the period under consideration June 2021 at -3.38 was the best year to expend on Miscellaneous Goods and Services.

14. The CPI for Non-Food 2008 to 2022.

Month	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Jan	6.21	7.61	5.68	5.94	6.85	5.37	5.01	3.92	6.94	17.38	12.27	17.76	18.77	5.87	17.60
Feb	6.26	7.51	5.66	6.02	6.90	5.45	4.97	3.98	7.17	18.42	12.26	17.29	20.08	4.24	18.42
Mar	6.29	7.2	5.81	6.19	6.89	5.27	4.88	5.12	6.38	18.48	13.35	16.98	20.44	3.88	21.86
Apr	6.25	7.28	6.03	6.1	6.67	5.36	4.85	5.04	6.93	18.84	13.35	17.13	19.08	4.67	22.92
May	7.17	6.98	5.74	6.01	6.92	5.22	4.62	5.24	7.96	18.21	13.70	21.64	14.58	3.57	24.84
Jun	8.41	6.7	5.67	6.05	6.93	5.33	4.56	5.19	8.40	18.75	13.94	21.85	12.33	4.53	28.66
Jul	9.43	6.57	5.92	5.91	6.30	5.63	3.93	5.13	9.48	18.07	16.53	21.26	10.18	6.40	29.61
Aug	9.14	6.73	6.4	5.77	6.09	5.51	4.67	6.04	8.38	17.98	16.79	21.82	9.84	7.47	26.58
Sep	9.16	6.24	6.42	6.27	6.07	5.50	4.55	6.02	9.60	17.47	15.79	21.33	19.46	10.21	25.37
Oct	9.07	6.32	6.53	6.2	6.09	5.49	4.47	5.99	11.32	16.27	15.00	21.85	10.14	11.59	28.41
Nov	9.13	6.5	6.68	5.98	6.10	5.35	4.53	6.00	14.47	14.04	16.42	21.53	7.35	13.28	29.38
Dec	9.07	6.5	6.75	5.95	6.18	5.22	4.61	6.46	16.39	13.09	15.56	21.31	6.94	16.75	30.60
Annual	7.97	6.85	6.11	6.03	6.50	5.39	4.64	5.34	9.45	17.25	14.58	20.15	13.35	7.71	25.35

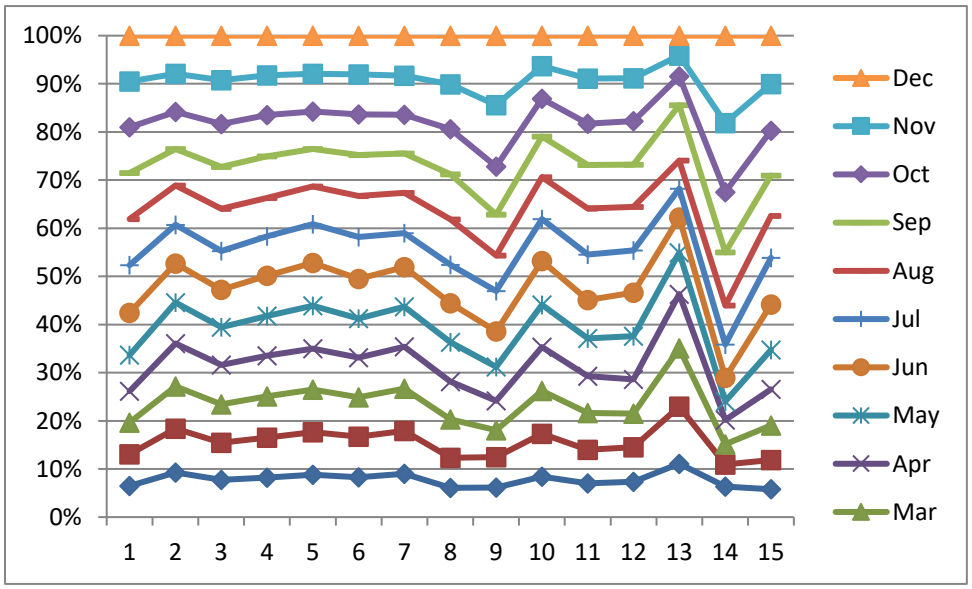
Source: Price and Labor statistics section, National Accounts and Economic statistics division, Stats SL.

14A. Annual CPI for Non-food 2008 to 2022.



Annual CPI for Non-food Items in 2022 at 25.35 percent over shadowed all other figures for the function during the period under review, next 2019 at 20.15 percent, 2017 at 17.25 percent, 2018 at 14.58 percent, 2020 at 13.35 percent, 2016 at 9.45 percent, and 2008 at 7.97 percent. The CPI for Non-food Items took a nose dive in 2014 at 4.64 percent.

14B. Monthly CPI for Non-food 2008 to 2022.



Monthly CPI for Non-food Items was at its maximum in December 2022 at 30.60 percent, pursued by July 2022 at 29.61 percent, November 2022 at 29.38 percent, June 2022 at 28.66 percent, October 2022 at 28.41 percent, August 2022 at 26.58 percent, and September 2022 at

25.37 percent. January 2015 at 3.92 percent was the lowest level in relation to the CPI for Non-food Items for the period under investigation.

Chapter 5: Summary, Conclusions, Suggestions, and Recommendations.

5.1.Summary

In Sierra Leone as in other countries, inflation is being monitored on a monthly and annual basis based on the CPI published by Statistics Sierra Leone. The Composite Consumer Price Index is computed as a weighted average of the different center sub-indices. The expenditure weights were obtained from the 2017/2018 Sierra Leone Integrated Household Survey (SLIHS) Income and Expenditure Module. The Consumer Price Index (CPI) basket in Sierra Leone currently covers a total of 400 items; and the CPI is estimated as a weighted aggregate of a fixed basket of these 400 goods and services popularly consumed in Sierra Leone. The index covers sampled outlets from five urban towns representing the four geographic regions of the country: Kenema and Koidu- Eastern province, Bo-Southern Province, Makeni-Northern Province and Freetown-Western Area. The current CPI reference year is 2007. All prices collected are the prevailing retail market prices from six (6) markets in Freetown, three (3) Markets in Bo Town, three (3) markets in Kenema Town, three markets (3) in Koidu and three (3) markets in Makeni Town for weekly prices, making a total of 18 markets as data collection centers for the CPI exercise in Sierra Leone.

Previously, With regards the Method used to update weights, the original weight reference period was 2003/2004, the year when the SLIHS was conducted for which expenditure weights are available. The SLIHS from which the weights were estimated covered the whole year which was thought of as the normal year, following the end of the war. Prices for all items in the basket were collected from May 2006 to May 2007 which serves as the price reference period. In practice the weight reference period should not be too distant from the price reference period. It was decided to re-reference the index to 2006/2007 and weight updates it to the same period. The price updated weights were computed by multiplying the 2003/2004 weights by elementary aggregate indices measuring the price changes between 2006/2007 and 2003/2004 and rescaling the results to 100. The elementary indices were computed by dividing the average prices for 2006/2007 by the elementary prices for 2003/2004. These were then multiplied by the 2003/2004 weights to derive the updated weights. This procedure preserves the 2003/2004 quantities and ensure that the resulting index is technically a basket index or a Lowe index with 2003/2004 quantities. A similar procedure is being used for the current weights being used for the new base year that has now been updated for a second time since 2003/2004 using the most recent SLIHS report available during that period.

As an index, the CPI shows where current average prices for a particular basket of goods and services land on a scale relative to a historic reference point. But it's more common to talk about the CPI's inflation rate, which illustrates how much prices have increased between two points in time (or decreased, in the event of deflation). Typically, you will see the inflation rate reported for all items included in the CPI. But it is also common to see it reported without

energy or food price changes, because those categories tend to be more volatile. This version of the index is known as “core inflation.” To calculate the CPI in the U.S, the bureau collects more than 80,000 prices per month from sellers and retailers in 75 urban areas. The price data captures the spending patterns of various populations. The most commonly cited versions of the index is the Consumer Price Index for all Urban Consumers (CPI-U), which shows the change in prices for the average household living in U.S cities. The CPI-U represents more than 90 percent of U.S consumers, making it the most broadly applicable. The BLS groups goods and services into categories, such as food, shelter, energy and medical care services. Average prices for each item are aggregated and used to calculate the CPI with complex statistics. Everything included in the index reflects its relative importance to consumers. The table below shows the relative importance assigned to some categories in the most recent U.S CPI report.

Relative importance assigned to some categories in the most recent U.S CPI report.

Group	**Relative importance in CPI**
Shelter	36.18%
Food	13.50%
Energy (fuel, utilities)	6.75%
Medical care services	6.50%
Transportation services (insurance, airfare, etc.)	6.39%
New vehicles	3.65%

Source: Bureau of Labor Statistics.

The Consumer Price Index is one of the most important economic statistics produced by Statistics Sierra Leone (Stats SL), in Sierra Leone/The Bureau of Labor Statistics (BLS) in the U.S. The CPI is a weighted measure of the average monthly change in the price of a fixed market basket of goods and services, it is important because it is a central target of monetary policy, and because changes in the CPI will significantly affect government data and public policy debate surrounding such issues as real wage and income growth. For example overstating inflation for say 25 years would mean that real inflation-adjusted monthly wages have actually increased by 13 percent instead of falling by 13 percent as is currently being reported. An inaccurate CPI has major implications for the government budget. A good portion of total government spending is indexed to movements in consumer prices. Social Security, military retirement, and civilian pensions account for the bulk of this spending. Tax receipts are also affected, since individual income tax brackets, personal exemptions, and the standard deduction are adjusted…that is…according to the CPI. Individual income taxes also account for a good portion of government receipts.

The Consumer Price Index (CPI) measures the overall change in consumer prices based on a representative basket of goods and services over time. CPI measures the monthly change in

price paid by consumers. Statistics Sierra Leone (Stats SL) calculates the CPI as a weighted average of prices for a basket of goods and services representative of aggregate Sierra Leone consumer spending. The CPI is the most widely used measure of inflation that's closely followed by policymakers, financial markets, businesses, and consumers. The calculation of the CPI indexes from the data factors in substitution effects – consumers' tendency to shift spending away from products and categories has grown relatively more expensive. It also adjusts price data for changes in product quality and features. The weighting of the product and service categories in the CPI indexes corresponds to recent consumer spending patterns derived from a separate survey, the Sierra Leone Integrated Household Survey (SLIHS).

The four major problems associated with CPI calculations are: (1) lower-level and upper-level product substitution bias (when the price of beef goes up, people buy more chicken); (2) an outlet substitution bias (as prices rise, consumers may switch to new discount stores not sampled by Stats SL, (3) a new product bias (new products are not introduced into the CPI, or are included only with a long lag in time; (4) a quality change bias (the price increase related to medical services are not adjusted for increases in the quality of care). There is also a temporal substitution bias (consumer purchase items on the weekends when products are on sale). Are there limitations to the consumer price index? The short answer is yes, a few. The key limitation is that the CPI does not apply to all population groups so it does not take into account the buying habits of people living outside urban or metro areas. Also, it does not consider the prices they are paying for the things they buy. So in that senses, it is not a true measure of how much price inflation the entire country experiences. The CPI also does not take into account other factors that affect cost of living, beyond prices for consumer goods and services. It does not measure social or environmental causes or trends that could cause prices to rise or fall over time. And with any statistical measure, leave room for a certain amount of sampling error.

In terms of using the consumer price index, the CPI has a number of uses. Many of them can directly or indirectly impact your financial life. Here are some of the most important uses of the consumer price index: 1. Measuring inflation. Inflation means a rise in prices that affects your purchasing power. As prices rise, your money does not go as far because you are spending more to pay for the same goods and services. The CPI can indicate inflation, how it is trending, and by extension, the effectiveness of current economic policy. 2. Measuring deflation. Deflation is when prices for goods and services drop and inflation falls below 0 percent. Purchasing power increases during periods of deflation but at the same time, the money supply also shrinks. Spending can also decline when the economy is deflating, as is usually the case following a recession. 3. Cost-of-living adjustments. The consumer price index ties adjustments in the cost of living index. That is important because the cost of living index determines things like Social Security benefit amounts and how much money you can contribute to tax-

advantaged retirement accounts on a yearly basis. Employers can also use cost of living adjustment data to increase wages paid to employees.

CPI is an economic term you have probably heard before but may not know much about. In the U.S Its importance has risen since President Biden's trillion-dollar spending initiatives aimed at countering the effects of the pandemic. And the April 2022 CPI report of a 8.3 percent jump from April 2021 has only furthered interest in this economic metric. Broadly speaking, the CPI measures the price of consumer goods and how they are trending. It is a tool for measuring how the economy as a whole is faring when it comes to inflation or deflation. When planning how you spend or save your money, the CPI can influence your decisions. Here is how. **Consumer Price Index Definition**. First, let's look at the formal definition of the consumer price index. According to the Bureau of Labor Statistics, the CPI is "a measure of the average change over time in the prices paid by urban consumers for a market basket of consumer goods and services." Now, let's break that down further. Average change over time means how prices rise or fall during a specific period. Urban consumers refers to people living in urban areas. So, for the purposes of calculating CPI, the BLS excludes those living in rural or non-metro areas, people who are imprisoned, and military families. A "market basket of consumer goods and services" means a specific group of items people buy. The CPI measures prices in several major categories of consumer spending, including: * Food and beverages * Housing * Medical care * Transportation * Education and communication * Recreation * Clothing * Other goods and services. The CPI does not factor in non-tangible things consumers spend money on. Intangibles can include life insurance or investments.

CPI and Monetary Policy: I. Role of CPI in Central Bank Decisions. The Consumer Price Index plays a pivotal role in the decisions of central banks worldwide, such as Bank of Sierra Leone and the Federal Reserve in the U.S. Central banks are entrusted with the task of maintaining price stability and controlling inflation. The Consumer Price Index serves as a crucial gauge of inflation, which provides insights into the general price data levels in the economy. II. How CPI Data Influences Interest Rates and Monetary Policy. CPI data has a direct impact on interest rates and monetary policy decisions. When the Consumer Price Index indicates rising inflation, central banks might opt to raise interest rates. This serves the purpose of curbing excessive spending, as higher rates make borrowing more expensive. Consequently, tempering demand and reining inflation. Conversely, If CPI indicates low inflation or deflation, central banks might lower interest rates to stimulate economic activity. And prevent deflationary pressures. II. CPI's Impact on Financial Markets and Investor Decisions. CPI data announcements have significant effects on financial markets. The anticipation of a rise or fall in interest rates based on CPI figures influences market sentiment. Equity markets, bond markets, and the foreign exchange markets all respond to CPI releases. Investors adjust their portfolios based on expectations about interest rates, currency values, and potential changes in economic conditions.

What are the Benefits of CPI? * Inflation Measurement. The primary benefits of the CPI is its role as a critical indicator for measuring CPI inflation data. It provides a comprehensive overview of how the prices of a broad range of goods and services are changing over time. * Policy Decisions. Central banks and governments use CPI data to make important policy decisions. It helps them assess the effectiveness of monetary and fiscal policies and make adjustments to manage the CPI in an economy. * Cost-of-Living Adjustment. Many contracts, agreements, and government programs are linked to the CPI. For instance, pension increases, social security benefits, and employment contracts might be adjusted based on changes in CPI to ensure that individuals can maintain their purchasing power.* Wage Negotiations. Labor unions and employers use CPI data during wage negotiations. It provides a benchmark for wage adjustments that reflect changes in the cost of living. * Investment Decisions. Investors use CPI data to adjust their investment strategies. It helps them account for the impact of inflation on their investment returns and purchasing power over time.

What are the Limitations of CPI? Along with the benefits, the Consumer Price Index also has some limitations, including; * CPI Basket of Goods. CPI assumes constant consumer spending patterns, which might not accurately reflect real-world consumption behavior. It does not consider changes in consumer preferences and the introduction of new products. * Substitution Bias. CPI does not account for the fact that consumers often substitute products when prices change. This leads to an overestimation of inflation as it does not fully capture consumers' ability to adjust their spending habits. *Quality Changes. If a product's quality improves over time, the Consumer Price Index might not fully capture the increased value consumers receive for their money. This can result in an overestimation of inflation. * Geographical Variations. CPI might accurately reflect the cost of living in different regions or cities. It provides a general picture and might not represent the inflation experienced by specific demographic groups. * Technological Advancements. CPI might struggle to account for the impact of technological advancements on products and services. The introduction of new technologies can alter the value proposition and quality of products, affecting the accuracy of CPI.

5.2 Conclusions

In Sierra Leone, the body responsible for collecting, compiling, analyzing, and disseminating high quality official price data through the Consumer Price Index (CPI) is Statistics Sierra Leone (Stats SL), the country's National Statistics Office (NSO). Prices in Sierra Leone are increasing either at an increasing rate or at a decreasing rate, except for some seasonal products whose prices tend to fall at their peak season, or when serious government policy, like fuel subsidization or the Free Quality School Education (FQSE) project, which allows for prices to stabilize across the economy (for fuel), or for a particular good or service (like education prices at primary, junior and senior secondary in government assisted schools, for the FQSE project).

The methodology employed by Stats SL has been harmonized to allow for the International Comparability of Prices (ICP), across the relevant Economic Commission of West African States (ECOWAS) countries. This collaboration has further been improved through the Harmonizing and Improving of Statistics in West Africa (HISWA) project, which have brought about funds being appropriated to around seven West African countries to run their National Statistics Offices (NSOs), including funding for the CPI.

Why is inflation so hard to measure? Despite numerous improvements that have been made historically and continue to be made by government statisticians in all countries, including Statistics Sierra Leone (Stats SL) and the U.S Bureau of Labor Statistics (BLS), many of them laboring under inadequate human and financial resource constraints, it is difficult to keep up with the dynamic change in the economy. New products are being introduced all the time, and existing ones improved, while others leave the market. Relative prices of different goods and services change frequently, for example, in response to technological and other factors affecting costs and quality, which leads consumers to change their buying patterns. There are literally hundreds of thousands of goods and services available in rich industrialized modern market economies. A single supermarket may contain 30,000 differently priced items, and a Wal-Mart store over 40,000. As countries become richer, demand has increasingly shifted to services away from goods, and to characteristics of goods and services such as enhanced quality, more variety, and greater convenience. Technology and entrepreneurship provide them. But all these factors, plus others, mean that a larger fraction of what is produced and consumed in an economy is harder to measure than decades ago, when a larger fraction of economic activity consisted of easier-to-measure items such as tons of steel and bushels of wheat.

The significant overestimate of the increase in the cost of living results because of a variety of methodological problems that occur when the CPI is calculated. To its credit, the BLS has a program of research and development activities aimed at improving the accuracy of the CPI, and Stats SL is continually working to harmonize its CPI methodology for international comparability with other ECOWAS countries. And since 1990, the BLS has implemented a number of improvements in addition to the soon-to-be-completed six-year CPI revision program. The combined effect of all these improvements is expected to reduce the rate of increase in the CPI by 0.7 percentage points per year compared to the early 1990s. These changes alone will raise federal revenues by $35.4 billion and reduce federal spending and interest payments by $61.6 billion up to 2003. BLS received more funding to expand the Consumer Expenditure Survey to facilitate more timely CPI market basket updates and the production of an official superlative index that is more accurate than the current CPI. The new funding will also enable the BLS to expand the use of quality adjustment methods. These are positive…but long overdue…steps that will further minimize bias in the CPI. **How CPI Data is**

Interpreted? Interpreting Consumer Price Index data requires considering both the index value and the inflation rate. A rising CPI index indicates overall price escalation, while a declining index suggests deflation. The CPI inflation elucidates the pace at which prices are increasing. A positive rate indicates inflation, while a negative rate indicates deflation. CPI report data is crucial for gauging changes in purchasing power and evaluating the cost of living. Economists, policymakers, and investors closely monitor CPI trends to make informed decisions about monetary policy, investments, and economic planning.

CPI is a proxy to inflation. Typically, consumers can expect the CPI to increase between about 1 percent and 4 percent each year in the U.S, based on data from the last couple of decades. However, the Federal Reserve wants to see the annual inflation rate staying around 2 percent. The CPI started to rise above normal levels during the pandemic until it appeared peak in June 2022, when the year-on-year increase was reported at 8.9 percent. The Fed took steps to slow down inflation by increasing interest rates. The effort appeared to be working based on the CPI's steady downward trend in 2023. But that progress has stalled in recent months. In March, the CPI rose faster than economists expected, according to Morningstar. **CPI vs. PPI**. The producer price index, or PPI, also is a measure of inflation calculated by the BLS and now Stats SL beginning to do so also. However, the PPI focuses on the change in prices from the seller's point of view, taking into account how much sellers pay producers for their goods. This index tracks average price changes for domestically produced goods, services and construction. **CPI vs. PPE**, like the CPI, the personal consumption expenditures, or PCE, is a price index that measures changes in how much consumers pay for gods and services. However, the PCE price index is calculated by a separate federal agency called the Bureau of Economic Analysis. The BEA uses a different formula to calculate inflation (and deflation, when prices decrease) and weights categories of goods and services differently. The two indexes also have different scopes. Unlike the CPI, the PCE includes spending done on behalf of consumers. One common example is medical spending. The CPI takes into account only what a household spends out of pocket on medical care. The PCE price index records that spending as well and adds what employers or government programs pay on consumers' behalf through insurance plans. Because the PCE and CPI differ in their formula, weighting, scope and other effects, their results are different. The Federal Reserve prefers to use the PCE price index to measure inflation. This comes into play when the Fed makes monetary policy decisions, such as whether to raise the federal funds rate.

There is a widespread consensus that the CPI significantly overstates the rate of increase in the cost of living. This problem received a great deal of attention, for e.g. in the US, following the release of the Boskin Commission Report – the Final Report of the Advisory Commission to study the Consumer Price Index ..in 1996. The Boskin Commission Report concluded that the CPI overstates inflation by 1.1 percent a year. In addition, the weight of evidence emanating

from the academic community, the Federal Reserve, the Congressional Budget Office (CBO), and even the BLS that the CPI has an upward bias is overwhelming. The upward bias has, and will continue to have, significant implications for public decisions. Even after the next set of revisions in the CPI is completed in 1999, significant upward bias will remain. Measuring prices and their rate of change accurately is central to almost every economic issue, from the conduct of monetary policy to measuring economic progress over time and across countries to the cost and structure of indexed spending and taxes. In the first external extensive evaluation of the nation's price statistics, for example, in the US since the Stigler Commission in 1961, the CPI Commission (see Boskin et al., 1996) concluded that the change in the Consumer Price Index (CPI) overstates the change in the cost of living by about 1.1 percentage points per year (the range of plausible values is 0.8-0.6 percentage points). That is, if inflation as measured by the percentage change in the CPI is running 3 percent, the true change in the cost of living is about 2 percent. This bias might seem small, but when compounded over time, the implications are enormous. Over a dozen years, the cumulative additional national debt from over indexing the budget would amount to $1 trillion. The implications of overstating inflation for understanding economic progress are equally dramatic. Instead of falling, average real earnings have risen, and instead of stagnating, real median income have grown, over the last quarter century. The poverty rate would be smaller. And because the CPI component price indexes are inputs into the national income accounts, real GDP growth is also understated.

BLS publishes two indexes each month. The Consumer Price Index for All Urban Consumers (CPI-U) represents 93 percent of the U.S population not living in remote rural areas. It does not cover spending by people living in farm households, institutions, or on military bases. CPI-U is the basis of the widely reported CPI numbers that matter to financial markets. It also publishes the Consumer Price Index for Urban Wage Earners and Clerical Workers (CPI-W). The CPI-W covers 29 percent of the U.S population living in households with income derived predominantly from clerical employment or jobs with an hourly wage. CPI-W is used to adjust Social Security payments as well as other federal benefits and pensions for changes in the cost of living. It also shifts federal income tax brackets to ensure taxpayers are not subjected to a higher marginal rate as a result of inflation. The inflation rate can be calculated for a given month or annual period, in either case, the appropriate new and prior period must be selected. The inflation rate is reported as a percentage and is often positive (assuming current market prices are appreciating).

To understand the U.S CPI, the Bureau of Labor Statistics collects about 80,000 prices monthly from some 23,000 retail and service establishments. Although the two CPI indexes calculated from the data both contain the word urban, the more broad-based and widely cited of the two covers 93 percent of the U.S population. Shelter category prices accounting for a third of the overall CPI are based on a survey of rental prices for 50,000 housing units, which is then used to

calculate the rise in rental prices as well as owners' equivalents. The owners' equivalent category models the rent equivalent for owner-occupied housing to properly reflect housing costs' share of consumer spending. User fees and sales or excise taxes are included, while income taxes and the prices of investments such as stocks, bonds, or life insurance policies are not part of the CPI.

To calculate the CPI Statistics Sierra Leone (Stats SL) / Bureau of Labor Statistics (BLS) has a process for calculating the consumer price index. First, the market baskets for each category and the urban areas for measuring prices are identified. To fix the market basket, the BLS looks at expenditure data that is self- reported by families and individual consumers over a two-year period. There is a gap between the period from which spending data is collected and when it is used to calculate CPI. So for example, if Stats SL/BLS were calculating the CPI for 2022, the data used to determine the market basket might come from 2019 and 2020. Next, the prices for individual items in the market basket in each urban area are determined. Stats SL/ BLS does this through in-person calls for the former and telephone sampling for the latter. In other words, they visit/call retailers and service providers to ask about pricing for various goods and services. The BLS can also collect this information through in-person visits. The consumer price index uses these two sets of data in its calculations. The formula for doing so looks like this:

CPI = Cost of market basket in a given year/cost of market basket in base year X 100.

The base year is a benchmark number that is used to measure changes in pricing from the given year. The consumer price index recalculates and updates monthly.

Inflation Rate = {(Current CPI –Previous CPI) / Previous CPI} X 100.

5.3 Suggestions.

The Consumer Price Index is a good index for its intended purpose – a measure of average price changes in the goods and services that consumers purchase. Some of the complaints made – that the CPI does not reflect the price changes for this or that group properly – are a misinterpretation of the purpose of the CPI and would not provide desirable guidelines for revising the index. Nor would any of the other available price indexes serve as well the purpose stated above for which the CPI is designed. While the CPI has serious limitations as a cost-of-living index for escalation purposes to hold standards of living constant, we know of no practical remedies for many of the most serious limitations. In view of the wide-ranging public functions served by the CPI, nothing is to be gained by indiscriminate criticism of it that could undermine the public's confidence in its acceptability. A constructive approach is to focus on feasible improvements. Over the years, the CPI has been improved, and there is room to improve it further. Our review of problems with the CPI leads us to the following suggestions concerning the weights of the index, its housing component, and how to deal with its limitations as an

escalator. The changing market basket pertains to a fixed basket of goods and services, which does not allow for substitution in consumption as a result of changes in relative prices. An index measuring the cost of a constant standard of living, on the other hand, would allow for substitutions that consumers make from higher to lower priced goods, provided that their standard of living is not changed thereby. In the escalation of pension payments, for example, a major objective is to maintain the standard of living of the pensioners. Since the CPI does not allow for substitutions of lower priced items that maintain the same standard, to that extent it overstates the escalation needed.

To allow for substitutions that provide the same standard of living as the original market basket is not, however, a simple matter. Critics of the CPI frequently overlook the point that simply substituting an item that has become cheaper for one that has become more expensive, say a pound of chicken for a pound of beef, will not ordinarily hold the standard constant. The substitutions must be equivalent in utility as judged by the consumer, and this usually means substituting a larger quantity of the cheaper item for a smaller quantity of something else. Estimating what these equivalent quantities are is the problem. The practical difficulties of doing so, in view of the differences in tastes among consumers, make the simplicity of a fixed basket attractive. While past studies indicate that the upward bias of the fixed market basket has been quite small, it should be monitored, nonetheless.

Statistics Sierra Leone (Stats SL) updates its base year every 10 years or so, and weights adjustments are regularly communicated as needed during refresher training of CPI data collectors. In 1978, BLS instituted a quarterly survey of consumer expenditures which, though less comprehensive than the major surveys made every dozen years or so, can provide the basis for more frequent revisions of weights. In addition this makes it possible to construct an index weighted by current expenditures and to extend it back in time for comparison with the present base-weighted index. This would show how much difference frequent updating of the weights would make. It is believed to be worthwhile to experiment with, and perhaps eventually to adopt, an average of a base-weighted and current- weighted index as the official index for escalation purposes. Such a combined index would avoid some of the upward bias of the present base-weighted index and some of the downward bias of a current-weighted index. Even if these biases are small over short periods, they may add up, over a period of many years, to an amount that is significant for escalating contracts or social security benefits. The combined index could be expected to approximate more closely than would either one separately an index representing the cost of a constant standard of living.

The homeownership factor. Housing presents special problems, some of a controversial nature. Some of the controversy is based on misinformation. A common but erroneous view is that the CPI assumes that every homeowner purchases his home every month at the going

price and pays the going mortgage interest rate. Stats SL/BLS should do everything possible to correct these impressions by explaining, in easily understood terms and in prominent places, exactly how the housing component is calculated. The ownership part of the housing component comprises the cost of houses, mortgage interest, insurance, taxes, and repairs. Each of these parts is priced and incorporated into the index according to its weight in the Consumer Expenditure Survey for BLS, or the Sierra Leone Integrated Household Survey (SLIHS) for Stats SL. Insurance, taxes, and repairs are recurring expenses and provide no special problems. It is the treatment of house purchases and mortgage interest payments that has attracted attention. The index uses current house prices and current mortgage interest rates. They receive a weight in the index according to the amount of expenditure made or contracted for by the household surveyed in the above mentioned surveys. If a household bought a house in that period, the total purchase price was counted as a current expenditure in the survey, while the current sales of houses by the same or other households were subtracted.

The interest cost of the mortgage financing over the first half of its life (since the average mortgage is terminated about halfway) was also counted as a current expenditure. The fact that the actual interest payment and amortization stretch over a period of years was ignored. For those households that did not purchase a house in the survey period, no house purchase or mortgage interest expenditure was recorded, whether these households then owned a home or not and whether they were making mortgage payments or not. For example in the U.S for the 1972-73 survey period, about 3 percent of households per year bought new houses. It is only the amount paid for houses and for mortgage interest by this 3 percent that determined the weights for these two items (after deducting house sales by households in the sample). The remaining 97 percent of households did not spend anything on the purchase of a house or take out a new mortgage. The rents paid by homeowners are of course, included as a separate item in the housing component. Many people find the zero house purchase and mortgage expenses for the 97 percent to be puzzling and are critical of it, but the explanation is simply that these households did not purchase houses or commit themselves to mortgages in the survey period. The purchases or commitments were made before the survey period. In view of the large swings in the volume of purchases of new houses, the development of a current-weighted index is especially important for the housing component. Its existence would help to dispel much of the controversy about this part of the CPI by revealing what difference it would make if current patterns of expenditure were taken into account.

Alternative measures. The main controversial issue in the housing component is whether to stick with the present method, which treats the purchase of houses as a current consumer outlay, or to switch to a method which treats houses as an investment and includes only the current cost of their services. The main practical difference between these two is that the present method includes house prices with a weight based on the total value of house

purchases in a 1-year period, whereas a cost-of-services method includes the capital cost of housing based on a rate of return to homeowners' equity. Both methods are the same in including other housing costs on a current expense basis, namely, mortgage financing, maintenance and repair, taxes, and insurance. Each of the two methods has its advantages and disadvantages. The present outlays method is relatively straightforward and has been the traditional practice for many years. However, it gives more weight to current house purchases than the cost-of-services method does. The latter, on the other hand, is more complex, requires estimates and assumptions regarding the appropriate rate of return to equity, and is harder to explain to the public. Some of the seeming arbitraries in this method, as exemplified in the various experimental indexes THE BLS now publishes, could be reduced by focusing on a single version which would reflect as far as possible the actual average capital cost to homeowners over the period since they purchased their current house. This involves a moving average of equity and financing costs over a period of years, weighted to reflect the actual experience of homeowners. Such a moving average of capital costs would be a smoother version of the experimental X-3 index now compiled by the BLS. Any index based on moving averages is not an up-to-date reflection of housing costs, however, and would be insensitive to the latest changes in house prices and interest rates. The present method has the advantage of reflecting current changes in house prices, but the other method is more representative of the trend rate of change of actual housing costs and, over a long period, would be more accurate for escalation purposes.

The equity costs in the cost-of-services method cannot be measured unambiguously, however, since there is no market transaction that supplies information on the capital cost of the equity to homeowners. Partly for this reason, most other countries largely ignore homeownership costs in their Consumer Price Indexes. A rental equivalent measure of owner-occupied housing costs is the most attractive approach, if a sample of rental housing can be developed that is representative of owner-occupied housing. A rental index obviates the need to estimate housing costs for each of its components and in particular avoids the ambiguities of capital costs. An alternative to the rental equivalent measure involves construction of an index of the costs of the services of owner-occupied housing – a user cost index. The proposal is to add up the current costs that the homeowner has to pay for housing services. These costs are equivalent to the rent that would be charged if someone were to provide these services in a competitive market (and if the tenant cared for the house as though he owned it). The rent would have to cover not only the usual outlays for maintenance and repairs, taxes, and insurance, but in addition the cost of the capital funds tied up in the house. The latter can be viewed as the investment return on an asset, namely: (1) the alternative market rate of return on the homeowner's equity and the interest rate on the mortgage, and (2) the change in market price of the asset over the period (an addition to or subtraction from the return, which reflects the combination of physical depreciation due to aging and capital gain or loss due to

market price developments). The basic problem with user costs is that the alternative rate of return on homeowners' equity is ambiguous because it is not clear what the alternative is. Since such a rate cannot be defined and measured, it must be inferred. In the U.S, the BLS has proposed to approximate it by the rate of interest on new mortgages (probably the best proxy that could be chosen), but this clearly gives an inaccurate approximation for many years and produces anomalous results. When capital gains on homeowners' equity due to increases in house prices are deducted.

5.4 Recommendations

Improving the Consumer Price Index will involve both the executive branch of government and parliament. Research and development activities that address the existing methodological problems must be undertaken and sustained by those in the executive branch who have relevant expertise. At the same time, by exercising its oversight responsibilities, Parliament should ensure that the government resources dedicated to such an effort are used effectively to achieve the desired goal of improving the quality of the CPI. The measures that can be taken include the following.

The President, The ministry of planning and economic development, ministry of finance and the Bank of Sierra Leone, have authority to direct Stats SL to correct the CPI as part of the current improvement using its oversight initiative. One of the Statistician General's primary goals in improving the CPI should be to create an index that more accurately reflects changes in the cost of living. A perfect cost-of-living index is not possible in a complex economy, but Stats SL should continually strive for that goal. The minister of planning and economic development (Stats SLs supervisory ministry) should establish a permanent and rotating panel of experts to review progress, conduct research, and make recommendations for further improving the CPI data collection and analysis. Stats SL need a more permanent, ongoing mechanism for bringing in outside information, expertise, and research to improve the CPI on a timelier basis.

In Sierra Leone, the ministry of planning and economic development in full cooperation with the ministry of finance and the Bank of Sierra Leone should strengthen an oversight process and appropriate additional funding for the CPI improvement. Index linking, the process of adjusting the wage rate to reflect market prices should be considered seriously for the welfare of the citizens of the country. Although modifying inflation adjustment for Social Security benefits, is necessary at this time, parliamentary oversight is also necessary. Some policy makers have suggested changing the inflation adjustment formula for Social Security benefits to the annual percent change in the CPI minus 1.0 percent to account for the upward bias in the current CPI. Modifying the index which is a CPI-U to include Kailahun district and the two newly established districts, Falaba and Karene districts, which is currently left out in the calculation of the index due to funding gaps to take care of staff and equipment.

The CPI is a good tool to use to measure inflation and deflation, and what each one means for your spending power. It also has its use from a saving and investing perspective. If the CPI is signaling that a period of inflation or deflation may be on the horizon, that might encourage you to make strategic moves to preserve cash savings and other investments. For example, you may want to increase your liquid cash reserves if prices are dropping. That fall could signal a broader economic slowdown. On the other hand, if prices are picking up, you might consider making defensive moves in your portfolio to hedge against inflation. Investing in Treasury inflation-protected Securities, money market funds, commodities, real estate or bonds are all ways to counter some of the effects of inflation on your investments that benefit from a period of inflation, such as growth stocks or mutual funds.

On an individual level, some saving and investing tips taking into cognizance the CPI trends might be. Talk to a financial advisor if you are concerned about how inflation or a recession could impact your investment portfolio. An advisor can answer your questions about the potential impacts of inflation or deflation. An advisor also can help you devise an investment strategy insulating you from either. Finding a qualified financial advisor does not have to be hard. SmartAsset's free tool matches you with up to three financial advisors who serve your area, and you can interview your advisor matches at no cost to decide which one is right for you. If you are ready to find an advisor who can help you achieve your financial goals, get started now. If you are planning to grow your emergency fund or shore up cash, mind where you keep your money. Higher-yield savings account or CD, for instance, can offer more growth than traditional counterparts. Shop around at different banks to see who is offering the best combination of higher APY and minimal fees.

NSOs require a Continuous process improvement in the Consumer Price Index (CPI) which is a strategic approach to constantly evaluating and refining business processes to optimize efficiency, quality, and overall performance. In today's dynamic business landscape, where technology and customer expectations evolve rapidly, staying stagnant can quickly lead to falling behind. Organizations can gain a significant competitive edge by continuously seeking improvements, big or small. CPI fosters a culture of innovation, helping businesses stay adaptable, reduce waste, and deliver enhanced customer value. Three tips for continuous Consumer Price Index (CPI) process improvement are:

1.Stats SL/BLS and all other National Statistics Offices (NSOs) should Implement A structured collaboration Framework. Develop a consistent framework for identifying improvement opportunities, analyzing data, implementing changes, and measuring their effectiveness to be flexible enough to adapt to different processes while ensuring consistency and quality in the CPI efforts. Consider viewpoints from different subject matter experts within your team to ensure

that approaches and ideas are examined critically from multiple relevant perspectives. Utilize tools like process maps and project management tools to visualize your processes.

2. NSOs should Practice a work style of continuous Learning and Drive. Equipping their team with the knowledge and skills necessary to effectively participate in the CPI process, including training on problem-solving techniques, data analysis tools, process mapping, and project management approaches. Empower your internal and external experts to be clear, confident, and decisive decision-makers and observers guiding other team members with other domain or technical expertise and clear roles and responsibilities. Teach your team to embrace and learn from failure, develop the grit and spirit to get back up, keep going, and continue on the journey of process improvement even in the face of adversity with funding and staffing problems. And

3.Stats SL/BLS and all other National Statistics Offices (NSOs) should leverage Data and Analytics for Informed Decision-Making (there key task). They should define specific metrics that measure the success of your processes tied to your objectives and key results (OKRS), key performance indicators (KPIs), and dynamic strategic plan. Utilize data visualization tools built into your business intelligence, project management, and presentation tools to communicate and evaluate their insights effectively. The NSOs should make informed decisions based on their respective team's expertise, experience, and insights from the data to empower their organizations to improve. How NSOs should get started for continuous product improvement: * They should gather a team, assemble the necessary experts and team members to support their process improvements. * They should identify key areas, focusing on processes directly impacting their objectives and priorities in terms of data collection, analyses, and interpretation of CPI data. * They should choose a pilot project, by starting small like selecting the requisite experts, to equipment, to harmonizing methodologies, and then analyzing and interpreting the data for final users. They should choose a manageable process for their first improvement effort.

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Appendix

2009

COICOP Function	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
Food and Non-alcoholic beverages	8.89	8.73	8.33	8.04	8.17	7.98	7.61	7.77	8.43	8.37	8.39	8.88	8.30
Alcoholic beverages	4.51	4.47	4.54	4.9	6.17	5.84	5.95	5.43	5.43	5.3	4.91	4.79	5.19
Clothing	5.28	5.36	5.13	5.01	4.82	3.93	3.66	4.11	4.13	4	4.41	4.48	4.53
Housing	7.65	7.7	7.73	7.56	7.48	6.95	5.73	5.83	5.74	5.63	5.76	5.78	6.63
Furnishing	8.44	8.53	8.28	8.25	7.99	9.23	8.79	9.15	8.85	8.74	10.1	10.18	8.88
Health	8.69	8.14	7.41	8.09	7.07	6.63	7.74	7.99	6.21	6.75	7.49	7.27	7.46
Transport	9.99	9.84	9.84	9.91	9.78	10.18	10.13	10.2	10.55	10.59	10.37	10.37	10.15
Communication	5.09	5.09	5.09	7.69	7.67	7.67	7.67	7.67	7.67	7.67	5.52	5.42	6.66
Recreation	6.38	6.59	6.53	7.14	7.03	6.5	6.45	5.77	6.38	6.31	6.58	6.58	6.52
Education	7.97	7.97	7.36	7.32	6.98	6.98	6.37	6.62	5.42	5.42	5.53	5.59	6.63
Restaurant	4.91	5.44	5.25	5.43	8.5	8.37	8.27	7.82	8.24	7.85	7.85	8.84	7.23
Miscellaneous	8.82	8.74	7.86	5.72	4.38	4.19	4.42	4.6	4.15	4.33	3.41	3.76	5.37
All Items	8.17	8.03	7.7	7.63	7.49	7.26	7.04	7.17	7.18	7.2	7.29	7.53	7.47
Non-Food	7.61	7.51	7.2	7.28	6.98	6.7	6.57	6.73	6.24	6.32	6.5	6.5	6.85

Source: Price and Labor statistics section, National Accounts and Economic Statistics Division, Stats SL.

2010

COICOP Function	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
Food and Non-alcoholic beverages	8.71	9.09	9.44	9.22	8.67	8.32	8.64	8.34	8.16	8.18	8.19	8.26	8.60
Alcoholic beverages	4.67	4.92	5.09	5.03	4.41	4.19	5.16	5.57	5.74	5.55	5.51	5.51	5.11
Clothing	5.75	5.57	5.86	6.23	6.57	6.68	7.07	6.98	7.42	8.56	8.21	8.38	6.94
Housing	6.23	6.15	6.18	6.25	6.23	6.3	5.49	5.61	5.7	5.77	5.71	5.71	5.94
Furnishing	8.46	8.91	8.99	8.88	8.98	7.87	6.99	7.09	7.36	8.28	6.94	6.89	7.97
Health	5.71	5.79	6.07	6.93	5.99	6.14	7.68	9.42	9.3	8.75	9.88	10.15	7.65
Transport	5.32	5.32	5.35	5.23	4.86	4.48	4.81	4.78	4.19	4.25	4.4	4.64	4.80
Communication	4.9	4.9	4.9	2.36	2.36	2.38	2.38	2.38	2.38	2.38	2.4	2.4	3.01
Recreation	6.23	5.98	5.96	5.36	4.9	5.06	5.03	6.07	5.31	5.28	5.14	6.55	5.57
Education	2.18	2.11	2.08	3.35	3.35	3.35	3.46	3.69	3.69	3.69	3.72	3.02	3.14
Restaurant	7.09	6.92	6.92	6.78	2.45	2.49	2.49	2.7	2.12	2	2.12	1.23	3.78

Miscellaneous	4.3	3.99	4.31	4.64	5.03	4.85	5.23	5.46	5.75	5.76	6.27	6.27	5.16
All Items	6.96	7.16	7.36	7.4	7	6.83	7.09	7.23	7.17	7.25	7.36	7.4	7.18
Non-Food	5.68	5.66	5.81	6.03	5.74	5.67	5.92	6.4	6.42	6.53	6.68	6.75	6.11

Source: Price and Labor statistics section, National Accounts and Economic Statistics Division, Stats SL.

2011

COICOP Function	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual Average**
Food and Non-Alcoholic beverages	7.91	7.56	7.56	7.91	8.04	8.01	7.79	7.8	7.77	7.59	7.64	7.47	7.75
Alcoholic beverages	6.2	6.66	6.77	6.88	6.98	7.24	6.3	6.3	6.55	6.68	6.8	7.13	6.71
Clothing	8.75	8.98	9.1	9.1	8.93	8.94	8.74	8.76	8.79	8.11	8.79	8.74	8.81
Housing	4.52	4.55	4.8	5.37	5.51	5.38	6.23	6.12	6.11	6.04	5.96	6.3	5.57
Furnishing	8.3	7.91	7.86	7.92	8.13	8.14	8.43	8.36	8.1	7.57	7.8	7.86	8.03
Health	7.23	7.23	7.69	6.74	6.38	6.62	5.68	5.09	6.87	7.2	5.68	5.42	6.49
Transport	4.12	4.12	4.18	4.27	4.41	4.46	4.3	4.27	4.88	4.82	4.87	4.52	4.44
Communicatio n	2.61	2.61	2.61	2.61	2.61	2.59	2.59	2.59	2.59	2.59	2.57	2.57	2.60
Recreation	6.29	6.56	6.7	7.08	6.56	6.32	5.77	4.55	5.09	4.91	5.53	4.51	5.82
Education	2.99	3.02	2.96	1.89	2.01	2.01	1.56	1.34	1.34	1.9	2.37	2.46	2.15
Restaurant	1.85	1.49	1.57	1.73	1.65	1.57	1.57	1.77	2.04	1.84	2.35	2.86	1.86
Miscellaneous	5.79	6.61	6.22	6.48	5.83	5.7	5.25	6.09	6.52	6.31	5.96	5.46	6.02
All Items	6.83	6.68	6.79	6.89	6.93	6.88	6.71	6.68	6.95	6.82	6.7	6.65	6.79
Non-Food	5.94	6.02	6.19	6.1	6.01	6.05	5.91	5.77	6.27	6.2	5.98	5.95	6.03

Source:Price and Labor statistics section,National Accounts and Economic Statistics Division, Stats SL.

2012

COICOP Function	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual Average**
Food and Non-alcoholic beverages	7.27	7.15	6.81	6.50	6.86	6.77	6.77	6.54	6.37	6.55	6.65	6.24	6.71
Alcoholic beverages	5.90	5.86	6.47	6.18	5.96	6.00	5.43	6.11	7.29	7.24	7.38	7.33	6.43
Clothing	8.23	9.09	9.40	9.60	10.25	10.53	10.62	10.56	9.84	9.97	9.75	10.11	9.83
Housing	5.91	5.95	5.93	5.47	5.47	5.69	4.64	4.59	4.67	4.78	4.77	4.43	5.19
Furnishing	7.20	7.22	7.33	7.84	7.66	7.45	7.14	7.12	7.11	7.46	7.72	7.64	7.41
Health	9.93	9.90	9.31	8.79	9.52	9.25	7.79	7.10	7.53	7.24	7.55	7.91	8.49
Transport	5.74	5.83	5.77	5.74	4.94	4.85	4.68	4.67	3.86	4.00	3.91	4.10	4.84
Communication	2.39	2.39	2.39	2.37	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40
Recreation	4.68	4.57	4.92	4.55	5.52	5.42	5.18	5.15	5.02	5.00	4.65	4.31	4.91
Education	1.85	1.82	1.79	1.60	1.69	1.69	1.88	2.28	2.28	2.05	1.55	1.46	1.83

Restaurant	2.36	2.28	2.24	2.08	2.47	2.59	2.70	2.81	3.08	3.58	3.68	3.20	2.76
Miscellaneous	6.61	5.69	6.42	6.00	6.47	6.57	6.61	5.30	4.95	4.99	4.69	5.31	5.80
All Items	7.03	7.02	6.87	6.60	6.87	6.88	6.53	6.26	6.20	6.30	6.34	6.20	6.59
Non-Food	6.85	6.90	6.89	6.67	6.92	6.93	6.30	6.09	6.07	6.09	6.10	6.18	6.50

Source:Price and Labor statistics section, National Accounts and Economic Statistics Division, Stats SL.

2013

COICOP Function	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual Average**
Food and Non-alcoholic beverages	5.67	5.63	5.83	6.13	5.76	5.57	5.80	5.94	5.51	5.44	5.34	5.59	5.68
Alcoholic beverages	6.78	6.44	6.17	6.45	6.60	6.34	6.53	5.93	4.89	5.29	5.33	5.68	6.04
Clothing	10.29	10.47	9.98	9.27	9.20	9.90	9.92	10.14	10.48	10.26	10.32	9.91	10.01
Housing	4.38	4.36	4.09	4.24	4.53	4.41	4.43	4.64	4.56	4.56	4.56	4.53	4.44
Furnishing	7.28	7.34	7.33	7.93	7.74	7.73	7.71	7.39	7.55	7.00	6.59	6.71	7.36
Health	5.06	5.18	5.02	5.33	4.41	4.44	5.76	5.14	4.96	5.00	4.45	4.12	4.91
Transport	3.74	3.74	3.77	3.90	4.07	4.07	4.02	4.05	4.72	4.84	5.10	5.25	4.27
Communication	2.28	2.28	2.28	2.78	2.75	2.75	2.78	2.78	2.78	2.80	2.80	2.80	2.66
Recreation	4.38	4.29	4.11	4.47	4.59	5.04	5.18	5.15	4.85	5.59	5.39	5.69	4.89
Education	1.31	1.37	1.91	1.91	1.79	1.94	1.69	1.08	1.29	1.08	0.99	1.14	1.46
Restaurant	3.40	4.65	5.25	5.14	5.04	5.08	5.27	5.40	4.81	4.87	4.10	3.47	4.71
Miscellaneous	4.07	4.19	3.53	3.47	3.59	3.96	3.66	3.86	3.72	4.06	4.11	3.74	3.83
All Items	5.49	5.54	5.52	5.71	5.47	5.43	5.71	5.70	5.51	5.49	5.36	5.37	5.53
Non-Food	5.37	5.45	5.27	5.36	5.22	5.33	5.63	5.51	5.50	5.49	5.35	5.22	5.39

Source:Price and Labor statistics section, National Accounts and Economic Statistics Division,Stats SL.

2014

COICOP Function	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual Average**
Food and Non-alcoholic drinks	4.82	5.14	4.98	4.71	4.42	4.38	4.03	4.91	4.90	4.55	4.40	4.63	4.66
Alcoholic beverages	5.79	5.77	5.70	5.25	5.05	4.99	4.78	5.55	5.08	4.97	4.90	4.19	5.17
Clothing	9.36	8.25	8.11	8.43	7.50	6.53	5.96	5.83	5.65	5.35	4.93	4.88	6.73
Housing	4.18	4.24	4.30	4.33	4.15	4.02	3.04	3.27	3.25	3.15	3.30	3.54	3.73
Furnishing	6.10	6.00	5.62	4.59	4.52	4.64	4.61	6.31	6.32	6.27	6.33	6.35	5.64
Health	4.45	4.69	4.72	4.82	4.85	5.17	3.74	5.21	5.38	5.46	5.55	5.60	4.97
Transport	3.86	4.09	3.33	3.30	2.96	3.06	3.18	4.17	3.03	2.77	2.19	1.84	3.15
Communication	2.66	2.66	2.66	2.17	2.17	2.17	2.14	2.14	2.15	2.14	2.14	3.05	2.35
Recreation	5.81	5.71	6.19	5.94	5.53	5.25	4.84	5.55	5.88	5.34	5.87	5.54	5.62
Education	1.47	1.71	1.22	1.22	1.16	1.81	1.84	2.08	1.43	1.31	2.64	2.55	1.70

Restaurant	3.36	2.53	2.44	2.51	2.19	2.69	2.64	5.48	6.05	6.88	7.80	8.66	4.44
Miscellaneous	3.83	4.56	4.78	4.89	4.97	4.73	5.07	5.71	5.55	5.57	6.02	6.52	5.18
All Items	4.91	5.03	4.91	4.78	4.52	4.49	3.98	4.79	4.69	4.49	4.48	4.61	4.64
Non-Food	5.01	4.97	4.88	4.85	4.62	4.56	3.93	4.67	4.55	4.47	4.53	4.61	4.64

Source:Price and Labor statistics section, National Accounts and Economic Statistics Division,Stats SL.

2015

COICOP Function	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual Average**
Food and Non-alcoholic beverages	5.25	5.18	6.37	6.58	8.41	8.92	8.86	9.46	9.54	10.26	10.50	10.75	8.34
Alcoholic beverages	4.64	5.00	5.68	5.78	5.97	6.13	5.85	6.09	6.16	5.96	5.55	7.11	5.83
Clothing	4.10	4.47	5.28	5.16	5.34	5.33	5.60	5.88	5.64	5.63	5.57	5.34	5.28
Housing	2.84	2.95	3.24	3.10	3.01	2.97	3.01	3.90	3.86	3.86	3.85	3.98	3.38
Furnishing	5.31	6.63	8.11	8.64	9.10	8.95	8.41	9.50	9.39	9.25	9.38	9.76	8.54
Health	4.52	4.19	5.31	4.74	5.34	5.26	5.05	6.69	6.61	6.38	6.70	7.97	5.73
Transport	1.05	0.56	2.36	1.94	1.64	1.94	2.11	3.32	3.52	4.35	4.57	5.85	2.77
Communication	3.16	3.16	4.62	4.63	4.63	4.63	4.63	5.56	5.54	5.64	5.72	4.78	4.73
Recreation	4.62	5.01	5.80	6.99	7.12	7.13	6.63	7.58	7.51	7.66	7.21	7.80	6.76
Education	2.36	2.09	5.33	5.36	5.41	4.55	4.67	4.75	5.45	5.45	4.14	4.51	4.51
Restaurant	9.37	9.12	13.45	13.70	14.48	14.17	14.58	14.97	14.73	13.44	13.36	12.76	13.18
Miscellaneous	6.26	5.83	7.60	8.33	8.55	8.66	8.27	8.55	8.61	8.50	8.63	8.32	8.01
All Items	4.52	4.51	5.68	5.71	6.65	6.84	6.77	7.58	7.59	7.90	7.98	8.38	6.68
Non-Food	3.92	3.98	5.12	5.04	5.24	5.19	5.13	6.04	6.02	5.99	6.00	6.46	5.34

Source:Price and Labor statistics section, National Accounts and Economic Statistics Division,Stats SL.

2016

COICOP Function	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual Average**
Food and Non-alcoholic beverages	10.23	10.54	9.66	10.84	10.13	10.74	12.53	13.10	13.17	14.04	16.19	18.62	12.50
Alcoholic beverages	5.97	5.40	4.85	5.41	6.51	7.77	8.64	8.43	9.69	10.78	14.03	15.19	8.56
Clothing	5.82	5.86	5.19	5.73	7.72	8.79	11.00	11.36	12.26	13.97	18.04	22.26	10.67
Housing	5.22	5.45	5.35	5.50	5.76	7.06	7.60	6.60	7.43	7.56	12.57	15.37	7.62

Furnishing	10.76	9.57	8.78	8.38	9.71	10.68	12.31	12.06	12.56	14.21	17.49	20.62	12.26
Health	8.04	8.76	7.93	9.63	10.66	9.67	11.13	8.71	11.32	14.11	13.81	13.12	10.57
Transport	5.40	5.68	4.82	5.37	8.42	8.54	8.10	6.17	6.52	6.54	13.98	14.50	7.84
Communication	4.12	4.30	2.87	2.96	2.98	4.38	5.47	4.62	5.36	5.78	9.38	13.61	5.49
Recreation	9.08	9.71	12.10	11.37	11.72	12.37	13.75	12.85	13.14	15.70	15.71	16.36	12.82
Education	5.48	6.00	2.77	3.44	3.57	3.77	4.29	4.29	7.17	9.11	9.78	9.40	5.76
Restaurant	13.58	16.59	12.23	12.79	11.88	12.10	12.15	8.54	8.63	9.83	13.44	17.25	12.42
Miscellaneous	8.92	8.96	7.43	7.17	7.58	7.56	8.38	7.31	7.45	13.37	17.13	21.22	10.21
All Items	8.41	8.70	7.85	8.69	8.93	9.47	10.87	10.52	11.32	12.54	15.27	17.42	10.83
Non-Food	6.94	7.17	6.38	6.93	7.96	8.40	9.48	8.38	9.60	11.32	14.47	16.39	9.45

Source:Price and Labor statistics section, National Accounts and Economic Statistics Division,Stats SL.

2017

COICOP Function	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual Average**
Food and Non-alcoholic beverages	20.19	21.52	22.28	20.95	19.72	19.60	19.13	18.07	18.24	17.55	18.88	17.93	19.51
Alcoholic beverages	18.81	22.00	24.01	23.92	22.95	22.59	22.73	24.80	24.13	23.84	22.73	22.96	22.96
Clothing	27.32	29.49	29.28	29.26	28.62	30.22	27.94	26.71	26.66	25.29	22.33	20.88	27.00
Housing	13.87	14.35	14.42	14.42	14.35	13.33	12.84	12.51	11.73	11.87	7.87	6.18	12.31
Furnishing	21.41	24.32	24.36	26.03	23.90	24.50	23.49	21.95	22.85	22.22	19.67	18.06	22.73
Health	12.39	13.15	12.93	12.89	11.52	13.28	12.76	12.62	10.99	9.08	9.71	10.08	11.78
Transport	19.81	20.28	21.62	23.97	23.29	22.93	23.42	23.22	23.78	23.30	15.41	14.43	21.29
Communication	14.40	15.38	15.42	17.38	18.09	17.96	17.39	17.72	19.19	19.58	16.82	13.20	16.88
Recreation	16.34	15.48	11.79	11.55	11.23	11.99	10.67	10.12	10.18	9.09	10.77	10.97	11.68

Education	8.34	7.81	7.88	7.26	7.03	7.10	6.52	7.10	4.23	2.60	3.44	5.01	6.19
Restaurant	19.13	15.92	16.59	17.02	19.03	19.27	19.26	21.38	23.16	23.91	20.42	20.02	19.59
Miscellaneous	22.54	23.93	24.10	24.32	24.44	25.23	25.17	27.83	28.52	22.64	20.32	17.22	23.86
All Items	18.67	19.82	20.23	19.80	18.92	19.14	18.56	18.01	17.82	16.87	16.26	15.32	18.29
Non-Food	17.38	18.42	18.48	18.84	18.21	18.75	18.07	17.98	17.47	16.27	14.04	13.09	17.25

Source:Price and Labor statistics section, National Accounts and Economic Statistics Division,Stats SL.

2018

COICOP Function	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual Average**
Food and Non-alcoholic beverages	17.50	16.87	16.72	17.21	18.73	19.64	19.08	19.78	20.05	17.26	16.68	12.77	17.69
Alcoholic beverages	20.51	19.52	18.82	19.38	20.00	21.01	21.77	20.38	22.31	17.39	22.12	16.23	19.95
Clothing	16.41	15.05	16.09	15.43	14.97	13.65	14.14	16.65	15.81	16.36	18.46	14.34	15.61
Housing	6.45	6.72	7.19	7.56	8.66	9.52	16.43	19.00	19.79	18.22	20.07	19.06	13.22
Furnishing	15.54	14.76	17.01	15.72	16.45	16.61	18.36	23.51	19.50	19.02	19.96	15.24	17.64
Health	12.27	12.69	14.76	15.32	16.11	16.64	17.40	15.58	15.43	15.60	16.68	22.19	15.89
Transport	10.38	10.19	9.45	7.67	6.19	6.58	14.68	16.69	17.90	17.71	19.26	21.31	13.17
Communication	11.45	13.52	13.77	12.41	12.09	11.38	11.51	-8.45	-8.81	-9.13	-9.54	-12.30	3.16
Recreation	10.32	11.33	13.26	14.12	14.65	13.87	14.38	14.09	16.89	14.19	14.90	10.01	13.50
Education	7.55	8.48	10.03	11.23	11.61	12.48	13.15	13.64	-13.71	-13.90	-14.65	-15.98	2.49
Restaurant	17.42	20.49	22.19	23.30	23.34	25.05	27.48	29.59	26.15	33.40	25.92	37.21	25.96
Miscellaneous	16.20	15.82	17.02	18.21	18.40	18.73	17.96	13.48	16.97	11.77	14.62	6.00	15.43
All Items	14.68	14.38	14.90	15.14	16.02	16.58	17.71	18.18	17.77	16.05	16.55	14.24	16.02

Non-Food	12.27	12.26	13.35	13.35	13.70	13.94	16.53	16.79	15.79	15.00	16.42	15.56	14.58

Source:Price and Labor statistics section, National Accounts and Economic Statistics Division,Stats SL.

2019

COICOP Functions	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual Average**
Food and Non-alcoholic beverages	10.56	10.50	12.29	15.91	7.51	6.64	7.67	8.28	8.31	9.08	3.62	5.39	8.81
Alcoholic beverages	19.13	18.93	17.90	22.17	18.27	16.25	16.97	17.56	12.84	16.10	4.99	11.55	16.06
Clothing	23.79	21.65	23.01	24.13	26.38	27.38	28.98	21.71	21.61	19.98	16.08	15.77	22.54
Housing	18.74	17.18	17.76	19.72	15.28	13.82	9.86	7.52	7.15	9.97	9.11	10.39	13.04
Furnishing	18.03	22.02	20.91	23.13	32.05	33.95	32.37	21.32	25.51	25.33	18.28	22.24	24.60
Health	22.91	21.24	20.53	16.07	32.44	36.12	37.61	53.74	46.24	45.62	47.57	39.95	35.00
Transport	18.87	17.88	17.31	18.78	20.74	21.00	18.04	13.09	13.87	13.57	11.72	11.47	16.36
Communication	-12.39	-5.95	-7.05	-7.52	2.21	2.58	-5.63	18.67	6.45	5.96	5.28	7.88	0.87
Recreation	12.67	19.69	12.68	13.80	8.50	5.19	5.65	3.09	-0.49	0.30	0.28	3.05	7.03
Education	-17.81	-18.07	-18.92	-19.10	-12.07	-20.84	-21.38	-22.22	2.19	2.19	71.35	71.35	-0.28
Restaurant	30.50	27.41	26.95	23.61	19.34	17.80	20.22	15.22	30.59	20.93	23.34	10.13	22.17
Miscellaneous	12.10	12.70	11.71	13.50	15.71	13.25	16.44	11.49	11.38	15.62	8.56	15.66	13.18
All Items	14.35	14.08	14.77	16.56	14.97	14.64	14.89	15.44	15.16	15.85	13.09	13.90	14.81
Non-Food	17.76	17.29	16.98	17.13	21.64	21.85	21.26	21.82	21.33	21.85	21.53	21.31	20.15

Source:Price and Labor statistics section, National Accounts and Economic Statistics Division,Stats SL.

2020

COICOP Function	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
Food and Non-alcoholic beverages	7.45	8.31	9.87	10.54	16.61	16.53	17.27	17.73	17.74	13.68	14.97	15.09	13.85
Alcoholic beverages	10.76	4.00	4.56	1.62	4.44	5.84	3.66	1.65	2.17	1.10	3.88	6.01	4.14
Clothing	8.15	10.10	10.33	10.43	8.30	7.87	7.32	12.97	13.43	18.25	17.40	19.15	11.98
Housing	10.34	11.54	8.17	1.98	5.69	5.83	2.96	2.68	3.47	-0.40	-3.58	-3.95	3.73
Furnishing	18.19	8.30	8.29	7.67	0.30	-1.18	-1.31	3.07	2.70	2.27	6.09	6.60	5.08
Health	35.46	46.21	48.46	52.31	33.61	21.78	19.03	9.56	13.75	13.13	10.76	7.44	25.96
Transport	17.78	19.03	17.50	14.10	11.86	15.01	10.59	12.69	9.02	7.43	7.38	6.64	12.42
Communication	7.22	2.00	8.59	8.52	-1.30	-1.28	5.55	4.40	12.60	11.72	12.05	15.86	7.16
Recreation	-0.17	-6.78	0.06	-1.11	2.89	5.94	6.41	9.40	10.37	10.10	5.41	4.73	3.94
Education	70.76	69.79	68.93	67.32	53.41	68.69	68.69	68.69	68.69	68.69	0.00	9.05	56.89
Restaurant	21.30	20.07	20.15	22.53	27.89	28.64	23.13	22.89	5.43	5.36	4.95	4.88	17.27
Miscellaneous	10.77	7.17	10.74	8.33	6.44	8.87	2.92	11.94	8.01	8.90	8.65	6.42	8.26
All Items	13.60	14.70	15.56	15.08	15.48	14.36	13.30	13.32	13.70	11.72	10.63	10.45	13.49
Non-Food	18.77	20.08	20.44	19.08	14.58	12.33	10.18	9.84	10.46	10.14	7.35	6.94	13.35

Source:Price and Labor statistics section, National Accounts and Economic Statistics Division,Stats SL.

2021

COICOP Function	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
Food and Non-alcoholic beverages	18.89	19.59	15.45	15.64	17.56	17.12	15.41	14.89	13.29	18.17	18.83	19.40	17.02
Alcoholic beverages	2.75	8.26	9.97	13.80	12.22	12.17	19.51	24.21	28.19	29.65	30.73	24.41	17.99
Clothing	15.37	12.95	8.74	10.56	6.49	5.91	5.85	5.82	4.97	4.48	5.44	7.07	7.80
Housing	-3.95	-0.18	2.92	7.39	6.45	8.36	8.74	11.72	11.78	14.16	16.13	19.47	8.58
Furnishing	6.16	13.15	11.64	10.75	10.54	11.11	15.82	14.44	16.91	17.60	20.18	20.53	14.07
Health	8.85	-2.80	-1.86	-3.30	-3.65	0.21	0.86	0.66	3.84	4.31	3.89	12.47	1.96
Transport	1.33	4.86	6.22	8.01	6.87	3.67	10.85	20.10	20.88	22.30	23.27	21.82	12.52
Communication	16.29	10.91	3.25	3.24	2.37	1.34	2.36	-0.09	1.66	2.48	3.96	7.17	4.58
Recreation	4.45	4.63	1.45	0.95	1.37	1.55	1.42	2.38	6.29	11.64	19.76	27.50	6.95
Education	9.05	9.05	9.05	9.05	9.05	9.63	9.63	9.63	30.82	45.25	57.22	53.35	21.73
Restaurant	-1.40	1.62	-1.20	-0.45	2.65	1.69	2.71	3.96	17.12	18.60	24.30	30.45	8.34
Miscellaneous	4.57	7.68	3.27	1.30	0.51	-3.38	1.13	-0.60	4.79	5.72	9.14	10.82	3.75
All Items	11.50	10.88	8.96	9.61	9.80	10.20	10.50	10.88	11.64	14.55	15.77	17.94	11.85
Non-Food	5.87	4.24	3.88	4.67	3.57	4.53	6.40	7.47	10.21	11.59	13.28	16.75	7.71

Source:Price and Labor statistics section, National Accounts and Economic Statistics Division,Stats SL.

2022

COICOP Functions	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
Food and Non-alcoholic beverages	15.68	17.09	22.96	23.00	26.29	28.49	30.58	31.60	35.20	40.14	43.62	46.70	30.11
Alcoholic beverages	24.09	22.28	23.57	18.77	20.65	23.72	17.64	15.74	3.11	7.96	13.01	14.84	17.12
Clothing	3.46	5.81	8.51	7.35	12.09	13.19	13.77	13.09	15.01	13.69	18.70	21.52	12.18
Housing	19.86	16.64	18.36	19.00	19.54	19.07	20.95	18.82	20.93	22.44	22.64	30.89	20.76
Furnishing	32.68	30.06	28.75	33.04	35.29	35.28	34.40	41.51	38.67	45.87	51.74	54.10	38.45
Health	12.93	18.91	18.90	18.10	20.24	22.88	19.54	21.22	23.79	25.70	28.54	26.98	21.48
Transport	21.42	15.95	35.75	37.51	37.52	52.20	50.87	25.16	29.93	42.13	40.55	44.89	36.16
Communication	6.96	7.47	9.90	11.10	10.51	11.83	11.52	9.94	11.60	11.99	11.02	3.96	9.82
Recreation	30.42	32.67	35.74	37.50	40.95	44.40	50.25	50.27	45.33	43.97	39.45	34.55	40.46
Education	53.35	53.35	53.35	53.35	53.35	47.67	47.67	47.67	15.28	3.82	-4.08	-9.82	34.58
Restaurant	32.62	33.78	39.24	41.45	40.19	46.55	51.63	53.97	42.87	48.80	43.94	41.74	43.07
Miscellaneous	11.56	11.35	13.54	17.48	19.72	27.89	29.24	31.28	24.97	27.77	31.94	38.39	23.76
All Items	16.65	17.59	22.06	22.44	24.87	27.95	29.47	28.15	29.10	32.98	35.05	37.09	26.95
Non-Food	17.60	18.42	21.96	22.92	24.84	28.66	29.61	26.58	25.37	28.41	29.38	30.60	25.35

Source:Price and Labor statistics section, National Accounts and Economic Statistics Division,Stats SL.