The Consumer Price Index
Columbus City Council Compensation Review Commission
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The City Charter ties officials' compensation to the Consumer Price Index (CPI). This is a summary of the CPI, what it measures, how it is calculated, and which CPI should be used to benchmark compensation.

Purpose and Calculation of the CPI

The CPI is one of several broad ways to measure inflation. Inflation is formally defined as a process of continuously rising prices – in other words, continuously declining value of money. In inflation, a dollar does not buy as much as it did earlier. The whole point of cost-of-living pay increases is to give workers the same purchasing power as they had before inflation hit. The CPI is designed to measure inflation and how much the dollar's purchasing power has changed between two specific periods.

The CPI is constructed by the U.S. Bureau of Labor Statistics (BLS) by measuring the price of a pre-defined basket of goods and services at a particular time and place. It is based on the prices of around 80,000 goods and services collected in 75 urban areas across the country. The prices of the items are weighted to approximate the purchasing patterns of a typical household. BLS surveys consumers' purchases to figure out what the correct weights should be. The result is the Consumer Expenditure Survey, which is useful in its own right.[1]

A price index shows the path of price changes over time. The price level at a specific date (called the base date) is set to a particular value. This is usually 100 and it is 100 in the CPI, but it does not have to be. The date chosen as the base date is also arbitrary. The index value in each following month is based on the change in the value of the basket relative to the base month. Say, for example, the price of the basket at the base date is $1,000. The price index is 100.0 (by definition). If the price of the basket the following month is $1,002, the index is calculated as the current month's price divided by the base date price times the initial value of the index:
$$1{,}002 / 1{,}000 \times 100 = 100.2.$$
One year later, say the price of the basket has increased to $1,050. The index is
$$1{,}050 / 1{,}000 \times 100 = 105.0.$$
In other words, you need $1,050 to buy the same things that $1,000 got you the year before.

The inflation rate is easy to calculate from the CPI. Inflation is typically measured from one year to the next or from one month to the next. (Monthly inflation rates are usually converted to annualized rates.) The inflation rate is calculated as the percentage change in the price index between the first and second date. If the index value at the first date is I_1 and the index value at the second date is I_2, this is:
$$\frac{I_2 - I_1}{I_1} = \frac{I_2}{I_1} - 1.$$

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[1] See U.S. Bureau of Labor Statistics. (2020). Consumer price index. *Handbook of Methods.* Retrieved from https://www.bls.gov/opub/hom/cpi/home.htm

In the example above, the change in the price index is 105.0/100.0 – 1 = 5.0%, which is the inflation rate. You can leave workers in the same position as they were last year by increasing their wages by 5%. Actual values of the CPI over the last three Decembers are as follows:

- December 2019: 256.903
- December 2020: 260.065
- December 2021: 275.703

The resulting inflation rates are as follows:

- December 2019-December 2020: 260.065 / 256.903 – 1 = 1.2%
- December 2020-December 2021: 275.703 / 260.065 – 1 = 6.0%

Average inflation for a year is calculated the same way, using the average CPI for each year rather than that for a particular month. This is illustrated later.

Types of CPIs

There are 10,614 different CPIs. They fall into several major category. The primary category is the type of consumer to which the index refers. These are Consumer Price Indices for All Urban Consumers (CPI-U), which is the most commonly used category, and Consumer Price Indices for Urban Wage and Clerical Workers (CPI-W). The difference between these two categories is the weighting of the items in the basket. CPI-W is designed to reflect the purchasing pattern of a lower-income household.

A second dimension is according to the breadth of the basket. Some indices are based on all items, while others track various subsets of the basket. These include indices tracking specific categories of groups of goods and services (e.g., food, energy, services, and healthcare) and dozens of very specific items. Other categories exclude groups of items. The most common of these is All Items Less Food and Energy. This is called the "core CPI." Prices of food and energy are especially volatile, so excluding those removes some of the noise and allows policymakers and analysts to see the underlying path of inflation more clearly.

Indices can be measured as their calculated value or on a seasonally adjusted basis. Seasonal adjustment is a statistical technique that removes the impact of a recurring change in prices or purchasing patterns. One example is the usual price increase in gasoline in late spring as refiners switch from winter blend to summer blend. Gasoline price increases at this point mean less than they do at other times of the year. (Because seasonal adjustment is a purely mathematical process, there is no need to figure out up front what forces are causing recurring pricing impacts. Sometimes you can look at the resulting seasonal adjustment factors and guess at the underlying forces, but not even that is necessary.)

Price indices also vary according to their geographical coverage. The broadest indices are U.S. city average. Other indices refer to broad regions of the country – Northeast, Midwest, South, and West – and to 25 metro areas (not including Columbus). A series of indices also track price changes by the size of the metro area. These are in four size classes. Size Class A is a population of 1.5 million or more; Size Class D is a population of less than 50,000. Regions are intersected with region size (e.g., Midwest Metros, Size Class A.

Finally, there is a series of 28 national-level "chained" CPIs that are designed to address a problem with the traditional CPI, discussed in the next section.

Problems with the CPI

As discussed above, the market basket used to calculate the CPI is based on the purchase patterns of a typical consumer. People in different places, different ages, different household types, and different income levels spend very differently. The CPI for wage-earners and clerical workers takes a stab at addressing this problem, but that is the only available reflection of this problem.

One problem arises from changes in quality of the underlying goods. The CPI basket includes a television, but at some point, that television changed from black and white to color, and at some point, it changed from a one with a picture tube to a high-definition flat screen. The pace of change in technology-dependent goods, such as computers, is even faster. Each change may have resulted in a price increase, but households probably wouldn't see it that way because the new good delivers more satisfaction than the old. People have experimented with ways to address this problem, but these fixes have been difficult to implement, so none has been. This means that you must be careful when looking at price changes over long periods, even four years. There is no practical way to fix the problem. You just must be aware of it.

A second problem is that purchasing patterns shift over time. Tastes change, new goods appear, and expenditure shares change. This means that the weights on the prices used to calculate the CPI become less relevant over time. The results of the Consumer Expenditure Survey are used to recalibrate the basket every two years.

Substitutions also happen much more dynamically as the price of goods and services shift relative to one another. If the price of margarine goes up and the price of butter comes down, people switch from margarine to butter. If the price of movies goes up, fewer people go to movies and more people stream movies at home or go bowling. The fact that the price of margarine and movies went up influences people's buying patterns. In some cases, many people shift their purchasing patterns. The higher prices of the items less commonly purchased consequently become less relevant. This means that the CPI with a fixed basket overstates the actual financial impact of changing prices on households.

The chained CPI is a response to the second and third of these three problems. The chained CPI is calculated like the traditional CPI except the weights on the goods and services change every month based on the results of the monthly Consumer Expenditure Survey. Because the chained CPI includes the impact of households' attempts to minimize the impact of rising prices, you expect the chained CPI inflation rate to be lower than the traditional CPI inflation rate, and it usually (but not always) is. The chained inflation rate from December 2019 to December 2020 is 1.5% rather than 1.2%, and the chained rate from December 2020 to December 2021 is 6.9% rather than 6.0% – but that rate is preliminary.

The chained CPI sounds like a solution to these problems. The Simpson-Bowles Commission on Deficit Reduction recommended the use of the chained CPI in setting Social Security benefits in December 2010 – although it was more because the chained CPI's measured inflation rate is usually lower than because it is a theoretically better measure. There is a potentially serious practical problem with using the chained CPI to set compensation, though. The chained CPI values come out with all the others – about three weeks after the end of the month to which they refer. But because the Consumer Expenditure Survey only comes out with a three-quarter lag, the index values for the past year or so are preliminary and are revised a couple times before they are final. On the other hand, the traditional CPI values are final on their first release – unlike most other BLS statistics. If a chained CPI is used to set compensation,

it will be necessary to specify a formal process to adjust compensation after the fact (possibly downward).

Which CPI Should Be Used to Benchmark Compensation?

As noted earlier, there are several different measures of price changes, but the CPI probably is the best for this purpose. The problem arises in benchmarking pay increases to no more than a four-year average of inflation. This is unwise because it makes the pay escalation unresponsive to changes in inflation. It is what economists call "sticky." If inflation increases as it has recently, the wage adjustments increase much more slowly and the officials lose purchasing power. If inflation declines, the average overstates current inflation.[2]

Which of the 10,614 CPI values should be used? It is better to use an all-items index rather than one excluding food and energy (the core CPI). Core inflation is more stable, but in real life officials do have to buy food and energy, so is unfair not to reflect this. The chained CPI is at least theoretically better, but you must be comfortable with ambiguity and figure out how you are going to reflect restatement of the inflation rate. The rate for the past year (one-quarter of your wage adjustment) is likely to change. You need to decide how to handle this. Do you retroactively adjust people's pay for the incorrect initial rate, or do you leave it alone? In any case, using the chained CPI requires formally setting a date on which the CPI values are retrieved to avoid any conflict later on. This is not an important consideration with the traditional CPI because those values don't change after they are issued. An annual-average inflation rate requires the use of the non-seasonally adjusted CPI because annual averages are not defined for seasonally adjusted series. In any case, measuring inflation year-over-year – even at a particular month – should also be done with the unadjusted numbers.

As mentioned earlier, there is no CPI for Columbus, but there are for Cincinnati and Cleveland. These should not be used for Columbus, though, because the demographics, economies, and purchasing patterns in Cincinnati and Cleveland are different from those in Columbus. Also, individual city and regional indices are more volatile than national indices. For that reason, BLS recommends that the national index be used for cost of living adjustments. (See Attachment A.)

The annual average values of this CPI to obtain the inflation rates for the last four years yields the following:

Year	CPI-U, U.S. city average	Inflation
2017	245.120	
2018	251.107	2.44%
2019	255.657	1.81%
2020	258.811	1.23%
2021	270.970	4.70%

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[2] However, the four-year average rate is the maximum adjustment. If inflation is declining and the four-year average were significantly higher than the rate for the most recent year, there would no problem with using the most recent rate as the cost-of-living adjustment.

The four-year average change would be calculated as:
$$(0.0244 + 0.0181 + 0.0123 + 0.0470) / 4 = 0.02545, \text{ or } 2.55\%.^3$$

The four-year average is 2.55%, much less than the 2021 average of 4.7%. Inflation is currently accelerating: as noted above, the 12-month rate to December 2021 is 6.0%. The 2.55% is a ceiling, so unless the inflation rate declines markedly over the next year, officials will lose purchasing power. While economists expect inflation to decline during 2022, the average forecast from the fourth quarter Outlook Survey of the National Association for Business Economics (NABE) is that the inflation rate will fall only to 2.8% by the fourth quarter of 2022.[4]

The two following attachments are first, BLS guidance for using the CPI for wage escalation, and second, a series of screenshots providing a step-by-step guide for downloading CPI values from the BLS website. Note that the BLS narrative includes a method for calculating inflation that is mathematically equivalent to the method outlined above, but that seems less straightforward.

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[3] There is a technical problem in using the standard average (called an arithmetic average), especially when negative changes are present. This is because a given percentage decrease is not the same as the same percentage increase. A more correct approach is to calculate a geometric average:
$$\sqrt[4]{(1 + r_1)(1 + r_2)(1 + r_3)(1 + r_4)} - 1 = \text{ average rate.}$$
In other words, you add one to each of the four rates, multiply them, take the fourth root of the product, and subtract one from the result. In this case:
$$\sqrt[4]{(1.0244)(1.0181)(1.0123)(1.0470)} - 1 = 0.02537.$$
The two answers are slightly different even though there are no negative percentages.

[4] The survey results are available at https://nabe.com, but only to NABE members.

Attachment A
How to Use the Consumer Price Index for Escalation

Source: https://www.bls.gov/cpi/factsheets/escalation.htm. Retrieved January 31, 2022.

The Consumer Price Index (CPI) measures the average change in the prices paid for a market basket of goods and services. These items are purchased for consumption by the two groups covered by the index: All Urban Consumers (CPI-U) and Urban Wage Earners and Clerical Workers, (CPI-W).

Escalation agreements often use the CPI—the most widely used measure of price change—to adjust payments for changes in prices. The most frequently used escalation applications are in private sector collective bargaining agreements, rental contracts, insurance policies with automatic inflation protection, and alimony and child support payments.

The following are general guidelines to consider when developing an escalation agreement using the CPI:

Define the base payment

Define clearly the base payment (rent, wage rate, alimony, child support, or other value) that is subject to escalation.

Identify which CPI series will be used

Identify precisely which CPI index series will be used to escalate the base payment. This should include the population coverage (CPI-U or CPI-W), area coverage (U.S. City Average, West Region, Chicago, etc.), series title (all items, rent of primary residence, etc.), and index base period (1982-84=100).

Specify reference period

Specify a reference period from which changes in the CPI will be measured. This is usually a single month (the CPI does not correspond to a specific day or week of the month), or an annual average. There is about a two-week lag from the reference month to the date on which the index is released (that is, the CPI for May is released in mid-June). The CPIs for most metropolitan areas are not published as frequently as are the data for the U.S. City Average and the four regions. Indexes for the U.S. City Average, the four regions, nine divisions, two city-size classes, eight region-by-size classes, and three major metropolitan areas (Chicago, Los Angeles, and New York) are published monthly. Indexes for the remaining 20 published metropolitan areas are available only on a bimonthly basis. Contact BLS for information on the frequency of publication for the 23 metropolitan areas.

State frequency of adjustment

Adjustments are usually made at fixed intervals, such as quarterly, semiannually, or, most often, annually.

Determine adjustment formula

Determine the formula for the adjustment calculation. Usually the change in payments is directly proportional to the percent change in the CPI index between two specified periods. Consider whether to

make an allowance for a "cap" that places an upper limit on the increase in wages, rents, etc., or a "floor" that promises a minimum increase regardless of the percent change (up or down) in the CPI.

Provide for revisions

Provide a built-in method for handling situations that may arise because of major CPI revisions or changes in the CPI index base period. The Bureau always provides timely notification of upcoming revisions or changes in the index base.

The CPI and escalation: Some points to consider

The CPI is calculated for two population groups: All Urban Consumers (CPI-U) and Urban Wage Earners and Clerical Workers (CPI-W). The CPI-U represents about 93 percent of the total U.S. population and is based on the expenditures of all families living in urban areas. The CPI-W is a subset of the CPI-U and is based on the expenditures of families living in urban areas who meet additional requirements related to employment: more than one-half of the family's income is earned from clerical or hourly-wage occupations. The CPI-W represents about 29 percent of the total U.S. population.

There can be small differences in movement of the two indexes over short periods of time because differences in the spending habits of the two population groups result in slightly different weighting. The long-term movements in the indexes are similar. CPI-U and CPI-W indexes are calculated using measurement of price changes of goods and services with the same specifications and from the same retail outlets. The CPI-W is used for escalation primarily in blue-collar cost-of-living adjustments (COLAs). Because the CPI-U population coverage is more comprehensive, it is used in most other escalation agreements.

The 23 metropolitan areas for which BLS publishes separate index series are by-products of the U.S. City Average index. Metropolitan area indexes have a relatively small sample size and, therefore, are subject to substantially larger sampling errors. Metropolitan area and other subcomponents of the national indexes (regions, size-classes) often exhibit greater volatility than the national index. BLS recommends that users adopt the U.S. City Average CPI for use in escalator clauses.

The U.S. City Average CPIs are published on a seasonally adjusted basis as well as on an unadjusted basis. The purpose of seasonal adjustment is to remove the estimated effect of price changes that normally occur at the same time and in about the same magnitude every year (e.g., price movements due to the change in weather patterns, holidays, model change-overs, end-of-season sales, etc.). The primary use of seasonally adjusted data is for current economic analysis. In addition, the factors that are used to seasonally adjust the data are updated annually and seasonally adjusted data are subject to revision for up to 5 years after their original release. For these reasons, the use of seasonally adjusted data in escalation agreements is inappropriate.

Escalation agreements using the CPI usually involve changing the base payment by the percent change in the level of the CPI between the reference period and a subsequent period. This is calculated by first determining the index point change between the two periods and then determining the percent change. The following example illustrates the computation of a percent change:
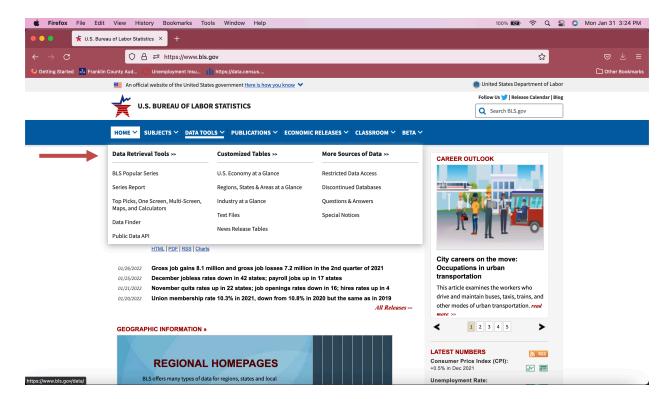
CPI for current period	232.945
Less CPI for previous period	229.815
Equals index point change	3.130
Divided by previous period CPI	229.815
Equals	0.0136
Result multiplied by 100	0.0136 x 100
Equals percent change	1.4%

The Bureau of Labor Statistics neither encourages nor discourages the use of price adjustment measures in contractual agreements. Also, while BLS can provide technical and statistical assistance to parties developing escalation agreements, we can neither develop specific wording for contracts nor mediate legal or interpretive disputes which might arise between the parties to the agreement.
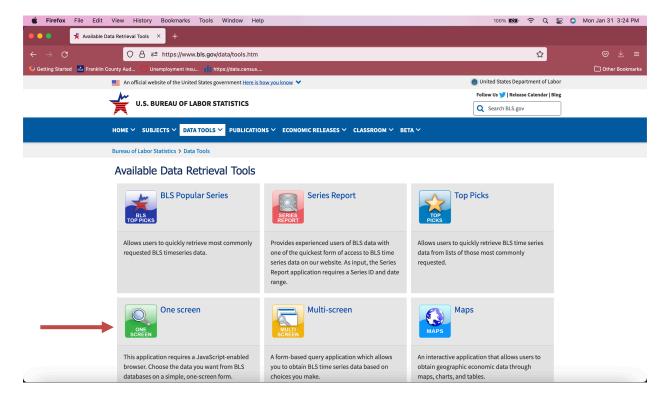
Additional information may be obtained from the Consumer Price Index Information Office at cpi_info@bls.gov or 202-691-7000. Information on the CPI's overall methodology can be found in the BLS Handbook of Methods.

Attachment B
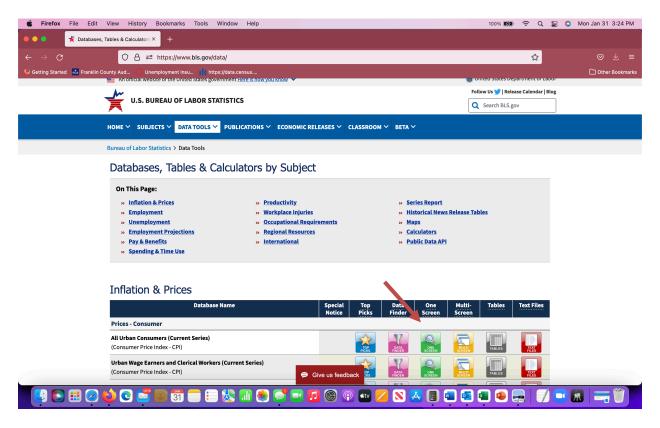**Retrieving CPI Values from the BLS Website**

These instructions will retrieve annual average values for the CPI-U, U.S. City Average, All Items. Open the Bureau of Labor Statistics website, www.bls.gov and click "Data Tools" in the blue menu bar at the top. A drop-down menu will appear, as shown. Click "Data Retrieval Tools" in the upper left-hand corner.
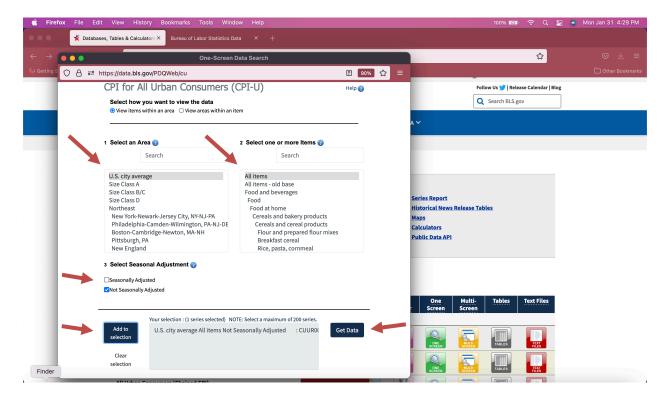
This brings up a page of data retrieval options. Click "One screen" in the second row to the left.

A page titled "Databases, Tables & Calculators by Subject" comes up, offering access to dozens of different BLS databases. The first entry on this page under Inflation & Prices is "All Urban Consumers (Current Series)." Click the green "One-Screen Data Search" button.

This opens a small menu screen. (You may need to enable popups.) Select "U.S. city average" as your area, then "All items," then click on the "Seasonally Adjusted" checkbox to unselect it. Once you have made all three selections, the dark gray "Add to selection" button turns black. Click that button, then click "Get Data."

By default, you get 10 years of data, not including annual averages. You need to click the "include annual averages" checkbox under the "Change Output Options" heading at the top of the page to get the annual averages that you need. While you are at it, you might also select 2017 to eliminate all the years that you do not need. Click "Go." You will end up with the display at the bottom. The annual averages are in the third column from the right.