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The Chained Consumer Price Index: A Brief Explanation

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Summary

The consumer price index (CPI) is probably the most important measure of inflation published by the federal government. It is used to adjust Social Security benefit payments as well as personal income tax brackets to keep up with inflation. Nonetheless, it has been subject to criticism. Because the CPI does not take into account consumers' ability to insulate themselves from inflation by changing their spending patterns, it overestimates how much they would need to raise total spending to maintain a constant standard of living. This is referred to as "substitution bias." As part of the continuing effort to improve the CPI, the Bureau of Labor Statistics (BLS) is introducing a supplemental measure which will be known as the *chained consumer price index for all urban consumers* (C-CPI-U). The C-CPI-U uses continuously updated expenditure weights, and thus reflects changes both in prices and in the composition of the consumer marketbasket. Because the new C-CPI-U will be subject to revision, with the final release two years after the reference date, it is an unlikely alternative for automatic indexing provisions. This report will not be updated.

The consumer price index (CPI) is probably the most important measure of inflation published by the federal government. Published by the Bureau of Labor Statistics (BLS) of the Department of Labor, it is used to adjust Social Security benefit payments as well as personal income tax brackets to keep up with inflation.[1] Nonetheless, it has been subject to criticism.[2]

The Current CPI Is a Fixed-Weight Index

[1] Actually, there are two CPIs. The consumer price index for all urban consumers (CPI-U) and the consumer price index for urban wage earners and clerical workers (CPI-W). Social Security benefits are indexed to the CPI-W, and income tax brackets are indexed to the CPI-U.

[2] In 1996, a group commissioned by the Senate Finance Committee issued a report which examined the CPI and made specific recommendations. See: *Toward a More Acurate Measure of the Cost of Living*, Final Report to the Senate Finance Committee from the Advisory Commission to Study the Consumer Price Index, Michael Boskin, Chairman, Dec. 4, 1996.

One of the criticisms, in particular, is that because the CPI is a fixed-weight index it does not adequately reflect changing buying habits.[3] As the overall level of prices rises, relative prices change as well. Some prices rise faster than average and some prices rise more slowly than average. When goods are reasonably close substitutes, consumers can change their spending patterns and buy relatively more of those goods whose prices are rising slowly, and fewer of those goods whose prices are rising rapidly.

If overall consumer satisfaction is unchanged once purchasing patterns respond to changed relative prices, then a price index based on a fixed marketbasket of goods and services will overstate the increase in cost of a given standard of living. Because the CPI does not take into account consumers' ability to insulate themselves, albeit to a limited extent, from inflation by changing their spending patterns, it overestimates how much they would need to raise total spending to maintain a constant standard of living. This is referred to as "substitution bias."[4]

The current CPI is a fixed-weight, or "Laspeyres," price index. In the simple case of two periods and two goods, the value of the index in the first period is one. The index value in the second period is a function of the quantities in the first period and the prices in the two periods. It is a weighted sum. The first step is to calculate, for each good, the ratio of the price in the second period to the price in the first period. The ratios are then summed using expenditure shares in the first period as weights. To see how a fixed-weight price index is calculated, see Box 1.

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[3] The CPI is, strictly speaking, a modified fixed-weight price index, in that the marketbasket is periodically updated. Until recently, however, those updates occurred only about once every 10 years. With the release of CPI data for January 2002, the marketbasket was updated to reflect spending patterns in the 1999-2000 period, and BLS now plans to update the marketbasket every two years. Thus, while the marketbasket may not be allowed to get too far out of date, it is always somewhere between two and four years out of date.

[4] Ana M. Aizcorb and Patrick C. Jackman, "The Commodity Substitution Effect in CPI Data, 1982-91," *Monthly Labor Review*, December 1993, pp. 25-33.

Box 1. Calculating a Fixed-Weight Price Index

To illustrate, consider the formula:

$$\mathbf{Index}^{\mathbf{L}}_{[1;t]} = \sum_{i} \mathbf{s}^{\mathbf{1}}_{\mathbf{i}} \left(\frac{\mathbf{p}^{\mathbf{t}}_{\mathbf{i}}}{\mathbf{p}^{\mathbf{1}}_{\mathbf{i}}} \right)$$

where i refers to the good, t refers to the period, and s^1 refers to the expenditure share for each good in the first period, and the following hypothetical values for prices and quantities:

	Beer			Wine			Total Cost
Period	Quantity	Price	Cost	Quantity	Price	Cost	
1	10	4	40	6	10	60	100
2	12	2	24	4	19	76	100

the index for period 1 is 1.000, and the index value for period 2 is:

$$\mathbf{Index}^{\mathbf{L}}_{\mathbf{2}} = \left[\mathbf{0.4} \times \left(\frac{\mathbf{2}}{\mathbf{4}} \right) \right] + \left[\mathbf{0.6} \times \left(\frac{\mathbf{19}}{\mathbf{10}} \right) \right]$$

$$\mathbf{Index}^{\mathbf{L}}_{\mathbf{2}} = \mathbf{1.340}$$

Using expenditure weights from the first period (in the case of beer, the expenditure weight is 40 ÷ 100 = 0.40, and for wine it is 60 ÷ 100 = 0.60), yields an index value in the second period of 1.340 which indicates an overall increase in the price of this marketbasket of 34.0%. In this case, the measure of price change does not take into account the fact that the hypothetical consumer bought more beer and less wine because of the change in relative prices.

The New Chain-Weighted CPI

As part of the continuing effort to improve the CPI as a measure of changes in the cost of living, BLS is introducing a supplemental measure which will be known as the *chained consumer price index for all urban consumers* (C-CPI-U).[5] The C-CPI-U will

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[5] Information from BLS about the C-CPI-U is available on the internet at: (continued...)

not replace the current CPI, and will not affect any current indexing provisions of federal government programs. The aim of the C-CPI-U is to produce a measure of change in consumer prices that is free of substitution bias.

The "final" release of the C-CPI-U will be calculated using a "Törnqvist" index formula.[6] This formula uses expenditure weights in both periods, thus it reflects both changes in prices *and* changes in the composition of the marketbasket. To see how a Törnqvist price index is calculated, see Box 2.

Box 2. Calculating a Törnqvist Price Index

The Törnqvist index formula looks like this:

$$\mathbf{Index}^{T}_{[1;t]} = \prod_{i} \left(\frac{p_i^t}{p_i^1} \right)^{\left(\frac{s_i^1 + s_i^t}{2} \right)}$$

In this case, for each good (i), the price in the second period (in this case p^t is simply p^2) is divided by the price in the first period (p^1) and the exponent applied to that ratio is the average expenditure weight of that good in both periods. In this formula, the $\prod$ symbol indicates that each of the weighted price ratios for the goods in the marketbasket are multiplied together. Continuing with the same hypothetical numbers from the previous example and using the Törnqvist formula gives:

$$\mathbf{Index}^{T}_{2} = \left(\frac{2}{4} \right)^{\left(\frac{.40+.24}{2} \right)} \times \left(\frac{19}{10} \right)^{\left(\frac{.60+.76}{2} \right)}$$

$$\mathbf{Index}^{T}_{2} = 1.175$$

Using the Törnqvist formula yields an index value for the second period of 1.175, indicating an increase in the price of this hypothetical marketbasket of 17.5%.

Because the Törnqvist index requires data on expenditures in both time periods it can not be published concurrently with existing CPIs. Expenditure data are not available in time. However, BLS will publish an "initial" estimate of the C-CPI-U based on an alternative formula. The release of this initial estimate will coincide with the release of

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[5] (...continued)
[http://www.bls.gov/cpi/superlink.htm].

[6] The Törnqvist price index formula was developed at the Bank of Finland in the 1930s.

other CPI data each month. In February of each year the previous year's C-CPI-U estimates will be revised, again using an alternative formula. This will be referred to as the "interim" release. In the following February, the C-CPI-U estimates based on the Törnqvist formula will be released.[7]

The "initial release" and the first revision, or "interim" release of the C-CPI-U, will be based on the same expenditure weights used for the CPI-U but the overall index will be based on a geometric mean formula.[8] In contrast with the Laspeyres index in which the quantities are held constant in both periods, the geometric mean index formula holds expenditure shares (price times quantity) constant. That means that if the price of a good rises the quantity consumed implicitly falls. To see how a geometric mean index is calculated, see Box 3.

Box 3. Calculating a Geometric Mean Price Index

The formula for a geometric mean price index looks like this:

$$\mathbf{Index}^{G}_{[1;t]} = \prod_{i} \left(\frac{p_i^t}{p_i^1} \right)^{s_i^1}$$

Using the same prices and quantities as in the previous example with this formula gives:

$$\mathbf{Index}^{G}_{2} = \left(\frac{2}{4} \right)^{.4} \times \left(\frac{19}{10} \right)^{.6}$$

$$\mathbf{Index}^{G}_{2} = 1.114$$

Using the geometric mean approach to calculating the price index for period 2 yields an increase of 11.4% between the two periods, less than either of the other two measures.

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[7] Neither the CPI-U nor the CPI-W is subject to revision. That the C-CPI-U will be subject to revision may make it less attractive for indexing purposes.

[8] A geometric mean is the root of a product of a set of numbers. The geometric mean of two numbers is the square root of their product. The current CPI already makes use of geometric means in calculating some of the component indexes. Geometric means were adopted for the CPI-U in January 1999 for use in aggregating some of the component indexes, where goods in a given category were relatively close substitutes. At the time, it was estimated that the change would result in a 0.2 percentage point drop per year in measured consumer price inflation. Kenneth V. Dalton, John S. Greenlees, and Kenneth J. Stewart, "Incorporating a Geometric Mean Formula into the CPI," *Monthly Labor Review*, Oct. 1998, pp. 3-7.

Some research has suggested that the geometric mean based price index may actually have a negative substitution bias. In other words, it assumes that consumers respond to changes in relative prices more than is actually the case.[9]

In estimating the initial and interim releases of the C-CPI-U, which will be calculated using the geometric mean formula, an adjustment will be made to the numbers based on the historical differences between the geometric mean index and the Törnqvist index, so that the initial and interim release will be closer to the final index number.

In the case of the first release of C-CPI-U data for the month of July 2002, the initial release will occur in August 2002, the interim release will occur in February 2003, and the final release will occur in February 2004. The earliest data available will be for January 2000, and the index base period will be December 1999 (i.e., December 1999 will equal 100).

The expectation is that the C-CPI-U will indicate a slightly slower rate of increase in prices than the CPI-U. Historical estimates suggest that the difference could be about 0.2 percentage points per year.[10]

The publication of the C-CPI-U is part of a continuing effort by BLS to produce a more accurate measure of inflation.[11] At a minimum, the C-CPI-U should yield a better estimate of the extent of substitution bias in the existing CPI. Its immediate practical use, however, may be limited. The final C-CPI-U which is calculated using the most recent actual expenditure data will only be available two years after the reference date. If it turns out that revisions to the C-CPI-U are very small, then it might become the preferred measure of inflation for those simply keeping track of overall economic conditions. But because it will be revised, and because the revisions will take some time, it may be an impractical measure of inflation to use for indexing.

It seems unlikely that the methodology of the C-CPI-U will be incorporated into the existing CPIs any time soon. The methodology of all the price indexes published by BLS is entirely within BLS' discretion, and the methodology of the existing CPI will likely continue to change as it has over the years. But one aspect of the existing CPI that seems unlikely to change is that it is not usually subject to revision once it has been published. That is one reason why the existing CPI is attractive for indexing. Given the time it takes to get the data for calculating the final C-CPI-U, it would not be possible to incorporate the C-CPI-U methodology into the existing CPI without also making it subject to revision.

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[9] Matthew D. Shapiro and David W. Wilcox, "Alternative Strategies for Aggregating Prices in the CPI," Federal Reserve Bank of St. Louis *Review*, May/June 1997, pp.113-125.

[10] Ibid.

[11] As part of that effort, BLS sponsored a panel of experts to examine the CPI and make specific recommendations. The Panel on Conceptual, Measurement, and Other Statistical Issues in Developing Cost-of-Living Indexes was chaired by Charles L. Schultze. Their report was published in 2002 by the National Academy Press under the title *At What Price? Conceptualizing and Measuring Cost-of-Living and Price Indexes*.