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Economics 202

How to Calculate the Consumer Price Index

1. What is a price index?

A price index represents a weighted average price for a specific set of goods and services. The CPI represents a weighted average price for a specific set of goods and services we believe is purchased by the typical consumer. Our goal is to determine the true price level, something we simply cannot know at any given point in time (i.e. we just don't have enough information to know the current or true price level at this very moment, because it takes time to figure it out), so we calculate the CPI as a way of at least approximating the true price level.

2. How do we calculate a price index?

In order to calculate a price index, we must compare the nominal value of a set of goods in what we'll call the current year to the value of that same set of goods in what we'll call the base year. If inflation has occurred, then the nominal value in that given year will increase above what we got in the base year. If deflation has occurred, then it's just the opposite.

Let's assume that we want to calculate a consumer price index for year 1. To do so, we must take the following steps:

- a) select a base year, this will be our comparison year
- b) as the CPI involves calculating a weighted average, then we must decide how we will weigh the prices of different goods and services within our basket. I.e., we don't want the price of toothpaste to play as big a role in affecting the average price of consumer goods as a change in the price of gasoline. The quantity purchased of each good does well in helping us know the relative levels of importance for each good (either that, or the percentage of expenditure on different items within the typical consumer's purchases).
- c) gather data on price and quantity purchased for various different goods and services

3. Calculating the CPI for year 1

To keep our example simple, let's assume that the typical consumer regularly buys only 4 different goods: clothes, meat, gasoline and books about economics. We'll further assume that each of these goods is purchased at the prices listed in the table. Year 1 is our current year, but year 0 will be our base year. We'll hold the quantities constant at the quantity of each good

purchased in the base year (note that we can use the quantities from any year here, as long as we keep the quantities constant throughout our calculation).

Table 1: Prices (Year 1 vs Year 0) and Quantities purchased – Typical Consumer

Goods	Price (Yr 1)	Price (Yr 0)	Quantity purchased (Yr 0)
Clothes	\$30.00	\$25.00	2
Meat	\$2.00	\$2.50	30
Gasoline	\$3.00	\$2.75	60
Econ books	\$12.00	\$10.00	10

If we assume that year 0 will serve as our base year, then the formula for calculating a price index in any given year (e.g. let's say year i) is:

$$\text{CPI(Yr } i) = \frac{((P_{1i} \times Q_{10}) + (P_{2i} \times Q_{20}) + \dots + (P_{ni} \times Q_{n0}))}{((P_{10} \times Q_{10}) + (P_{20} \times Q_{20}) + \dots + (P_{n0} \times Q_{n0}))} \times 100$$

where

P_{1i} = Price of good 1 in year i

P_{2i} = Price of good 2 in year i

P_{ni} = Price of good n in year i

P_{10} = Price of good 1 in year 0

P_{20} = Price of good 2 in year 0

P_{n0} = Price of good n in year 0

Q_{10} = Quantity purchased of good 1 in year 0

Q_{20} = Quantity purchased of good 2 in year 0

Q_{n0} = Quantity purchased of good n in year 0

If there are just 4 different goods, then $n = 4$ and we calculate $(P \times Q)$ for 4 goods, as follows:

$$\text{CPI(Yr } 1) = \frac{((P_{1i} \times Q_{10}) + (P_{2i} \times Q_{20}) + (P_{3i} \times Q_{30}) + (P_{4i} \times Q_{40}))}{((P_{10} \times Q_{10}) + (P_{20} \times Q_{20}) + (P_{30} \times Q_{30}) + (P_{40} \times Q_{40}))} \times 100$$

Let's assume that clothes are good 1, meat is good 2, gasoline is good 3 and books about economics will be good 4. Substituting in our various prices and quantities from above, we get:

$$\text{CPI(Yr } 1) = \frac{((\$30 \times 2) + (\$2 \times 30) + (\$3 \times 60) + (\$12 \times 10))}{((\$25 \times 2) + (\$2.50 \times 30) + (\$2.75 \times 60) + (\$10 \times 10))} \times 100$$

Note a couple different things from this calculation. First, note that the quantities are certainly not changing from year 0 to year 1. If they did change, then we wouldn't know if a larger (or smaller) denominator was caused by a change in prices or quantities. We can also see the relative importance of each good within the basket. E.g., gasoline carries a bigger weight than

clothes, and so plays a more important role in affecting the overall price level. Of course, as you'd expect, the same applies to the purchase of economics books vs clothes.

Our calculation above reduces to:

$$\text{CPI(Yr 1)} = \frac{\$420}{\$390} \times 100 = 107.69$$

The CPI in year 1 is 107.69.

3. How do we interpret our result?

One way to interpret our CPI is by restating what we were trying to measure. Our goal was to compare the expenditure by a typical consumer on a set of goods in two different years, in one year (in this case, year 1) to our base year (year 0).

Our interpretation follows accordingly:

A set of goods that would have cost the typical consumer \$100 in year 0 will cost that consumer \$107.69 in year 1. Although meat is slightly less expensive in year 1 (vs year 0), our typical consumer faces prices that have risen overall by almost 8% between these two years.