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Economics 202

Understanding the Consumer Price Index

The consumer price index is a fixed weight price index. I.e., a price index obtained by dividing the expenditure on a set of consumer goods in any given year by the expenditure on that same set of goods in the base year. To see how that works, let's assume that the typical consumers spends $20,500 on a specific set of goods in year 0. In year 1, that consumer spends $25,000 on the exact same set of goods. That said, the CPI for year 1 would be:

$$\text{CPI(Year 1)} = \frac{25,000}{20,500} \times 100$$

Note that we multiply our result by 100. This is a conventional operation and leads to our CPI in year 1 being equal to 122. Other CPI values are calculated in exactly the same manner, always dividing a given year's expenditure by that of the base year. Note that the current year is whatever year we reference when calculating the CPI. E.g., although year 0 is the base year, if we calculate a CPI value for year 0, the numerator of our calculation would be consumer expenditure on a specific basket of goods in year 0, the base year. The denominator is always the base year, and so calculating the CPI for year 0, the base year, would involve dividing $20,500 by itself. This tells us that any time we calculate CPI for the base year, we always get a result of 100. I.e., the CPI in the base year is always equal to 100.

1. Interpreting our result and calculating the inflation rate
Because the true rate of inflation cannot be observed, we can use the CPI (and similar price indexes) to help us approximate the true inflation rate. Looking at our example above, we calculated the CPI for year 1 as 122. Noting the comments below that result, we know that the CPI in the base year is 100. The most basic interpretation of this price level change between year 0 and year 1 is to say that a basket of goods which costs the typical consumer $100 in the base year, will cost that consumer $122 in year 1.

Given that the CPI in year 1 is 122, and CPI in the base year is 100, the inflation rate between these two years is calculated as the percentage change in the CPI between years 0 and 1:

$$\text{Inflation rate} = \frac{122 - 100}{100} \times 100 = 22\%$$

2. Problems with interpretation

a. Changes in product quality

Let's assume that government begins to require that gasoline refiners produce a cleaner burning gasoline. Refiners respond by adding certain chemicals to their gasoline, which we can interpret as an upgrade in the quality of their gas. If this change occurs in year 2, then this improved quality leads to a small increase in the price of gasoline during year 2. Given that gasoline is a relatively significant purchase for the typical consumer, we can assume that this rise in gas prices during year 2 has an effect on the CPI for year 2. Does this mean that inflation has gotten worse?

At first glance, a higher CPI value suggests that the average price of consumer goods and services is higher, but we need to consider what's happened here. As stated above, when calculating the CPI, we compare the prices of a specific set of goods in one year to the prices of that same set of goods in the base year. This allows us to find what we could call a pure price change, which is what the CPI intends to calculate, rather than changes in price changes due to changes in the characteristics of a product. Given that rising quality tends to cause prices to rise as well, and that quality moves upward, not downward, we know that quality change would cause the CPI to overstate the true price level.

b. Introduction of new goods

As stated above, the CPI is a fixed weight price index. We use the same set of goods when comparing prices in any current year to those in the base year, but what happens when the typical basket of consumer goods begins to change? E.g., in the 1980s, home entertainment expenditures included VCRs, but not DVD or Blueray players. When DVD players were developed, they replaced VCRs, and as Blueray players came into being, they similarly began to replace DVD players. If we ignore the change, then the consumer basket does not reflect the purchases of a typical consumer. If we try to include the new good, then we have to figure out what to do about the price of that good in the base year. We either change the base year or do our best to approximate the price.

c. Product substitution during inflationary times

When expenditure on the consumer basket is determined, we measure that expenditure in terms of some fairly general categories. Think about it like this. Rather than collect information about the price of specific brands of food, the CPI considers more general food categories like red meat, poultry, vegetables, etc. Therefore, this expenditure information is an aggregation of all different brands for that particular good, including name brands and generic brands.

Assume that the typical consumer buys only name brand food in year 0, but that the prices of that food begin rising during year 1. If prices rise, and your income doesn't, then your purchasing power is decreasing and you'll be looking for ways to save money at the supermarket. One

obvious option would be to buy cheaper generic brands instead of the more expensive name brands. When your expenditure is measured during a period where prices may be rising on average, we know that consumers may also be switching to lower priced generic goods. If so, then the CPI would reflect lower prices and the CPI would understate the true price level.

3. Converting Nominal Income into Real Income

It is common knowledge that the cost of living (or inflation) makes the income earned in 1899 very different from the income earned this year, and comparisons between income earned in a city like New York and a city like Louisville is similarly difficult. In these situations, we turn to the CPI for assistance. It is possible to use the CPI to deflate nominal income into real income. That is, remove the impact of inflation on income and convert that income into something we can compare over time or across locations that have a different cost of living.

Recall from above that the CPI in year 1 is 122. If the typical consumer earns $48,000 in year 0 and year 1 (nominal income), we know that this person's purchasing power has fallen. If we relate nominal income to the CPI, we can determine the impact of this higher price level on real income. In any given year, we divide nominal income by the CPI.

Let's say we want to determine the real income of the typical consumer in year 1 when the CPI = 122 and a typical consumer's nominal income is $48,000. That calculation would be as follows:

$$\text{Real Income(Year 1)} = \frac{\$48,000}{122} \times 100 = \$39,344$$

Note that if we calculated the real income of an individual in the base year (year 0), we would have the following calculation:

$$\text{Real Income(Year 0)} = \frac{\$48,000}{100} \times 100 = \$48,000$$

I.e., real income in the base year is the same as nominal income in the base year.