Lecture 9 - Application of Expenditure Function: the Consumer Price Index

14.03 Spring 2003

1 CPI

Consumer Price Index: index put out by the Bureau of Labor Statistics to measure changes in the cost of living.

But what is the cost of living? Formally the cost of living is attaining a fixed level of utility at different points in time.

What economic construct of consumer theory developed in class does this idea correspond to? Certainly the expenditure function.

Before we discuss how this works, let's see what this is used for.

1. Index private sector contracts including
   - Rents
   - Collective Bargaining Agreements
2. Social Security Payments
3. Income Tax Brackets and Prevents Bracket Creep
4. General measure of economic performance - how much have prices risen.
5. One third of federal budget outlays is indexed to CPI (most especially Social Security)

Given our knowledge of consumer theory, we can easily deduce the ideal cost of living index.

Given a change in prices from (p_{x1}, p_{y1}) to (p_{x2}, p_{y2}), the change in the cost of living is correctly measured by the following:

$$E(p_{x1}, p_{y1}, U_0) - E(p_{x0}, p_{y0}, U_0)$$

In order to make this an index:

$$1 + \frac{E(p_{x1}, p_{y1}, U_0) - E(p_{x0}, p_{y0}, U_0)}{E(p_{x0}, p_{y0}, U_0)} = \frac{E(p_{x1}, p_{y1}, U_0)}{E(p_{x0}, p_{y0}, U_0)}$$

By looking at the value of this index we could measure change in the cost of living:

- If $Index = 1$ there is no change in the cost of living
- If $Index = 1.1$ there has been a 10% increase in the cost of living
- If $Index = 0.9$ there has been a 10% decrease in the cost of living

So why is there a problem?

- Fundamentally we need exact knowledge of consumer utility to compute the ideal index
- Specifically we need the expenditure function or the hicksian demand function.

What could you do if you didn't know the expenditure function and you need to approximate changes in the cost of living?

1. Look at change in the cost of buying the same set of goods over time: forward looking LASPEYRES Index
2. Look at how much it would cost you to buy the goods you are consuming now at an earlier time: backward looking PAASCHE Index.

Let's look at each of these approaches formally; are they the same?

2 Laspeyres Index

$$L = \frac{p_{x1}x_{0+}p_{y1}y_0}{p_{x0}x_{0+}p_{y0}y_0}$$

How do these terms compare to the ideal index?
The denominator:

$$p_{x0}x_{0+}p_{y0}y_0 = E\left(p_{x0}, p_{y0}, U_0\right)$$

by revealed preferences.
The numerator:

$$p_{x1}x_{0+}p_{y1}y_0 \geq E\left(p_{x1}, p_{y1}, U_0\right)$$

since (x_0, y_0) might make the consumer achieve utility U_0 at (p_{x1}, p_{y1}) but not at minimum cost.

By fully compensating for price change ignoring substitution, we clearly improve consumer welfare.

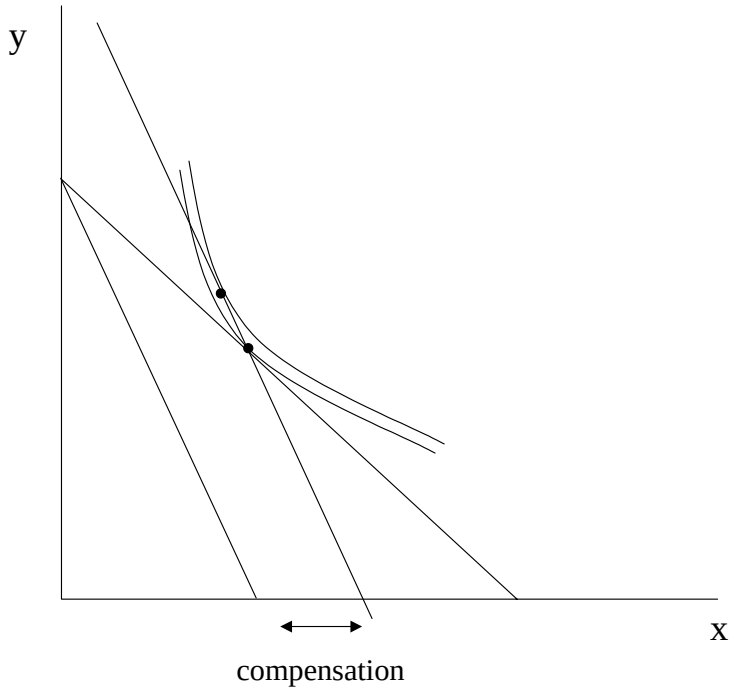

Figure 1:

Graph 47

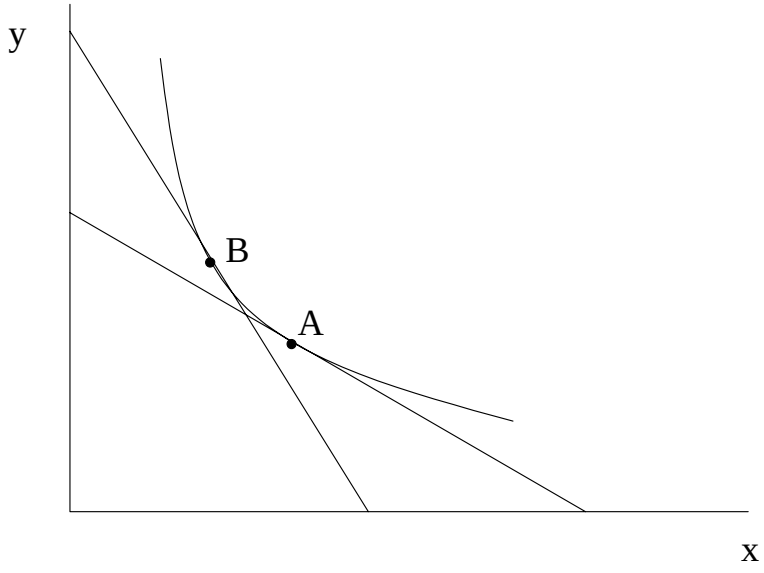

Figure 2:

For example in this graph the price of x increases and if we fully compensate for this price increase we make the consumer better off (consumer is on a higher indifference curve).

[Graph 46]

When would Laspeyres not overstate inflation?

If indifference curves are Leontief e.g. hotdogs and buns where you don't consume relatively more buns if the price of of hotdogs rises, but this is an absurd example for a bundle of 9,108 goods.

Q: Is it possible to have a case where $L > 1$ when the cost of living is unchanged?

[Graph 47]

Notice that point A is no longer feasible, but $B \ ^I \ A$.

This could occur if the price of one good fell and the other rose while income was fixed.

- Case where Laspeyres $L = 1$, where consumer is better off.

  Take the case where $L = 1$, but $p_{x1} \neq p_{x0}$ and $p_{y1} \neq p_{y0}$.

Graph 48

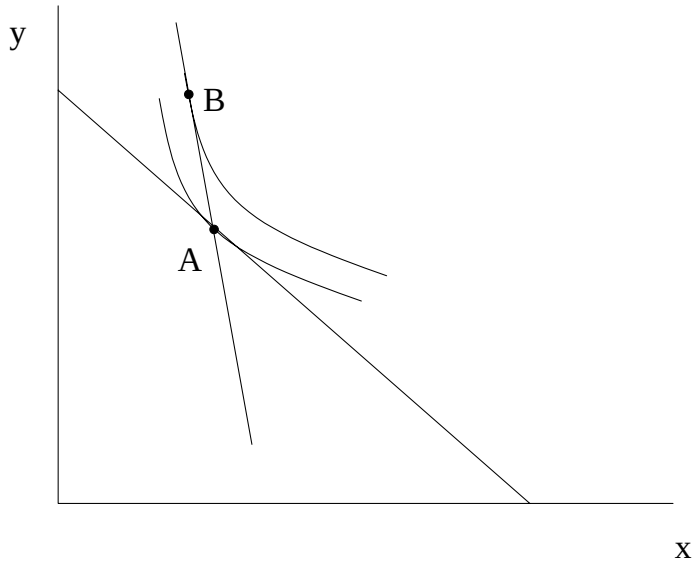

Figure 3:

[Graph 48]

Q: Could you have $L < 1$ and consumer worse off?
A: No, because the old budget set is still attainable.

3 Paasche Index

Now consider the Paasche index:

$$P = \frac{p_{x1}x_{1+}p_{y1}y_1}{p_{x0}x_{1+}p_{y0}y_1}$$

Let's see how this index compares to the expenditure function measure of the cost of living.

The numerator:

$$p_{x1}x_{1+}p_{y1}y_1 = E(p_{x1}, p_{y1}, U_1)$$

by revealed preferences.

Graph 49

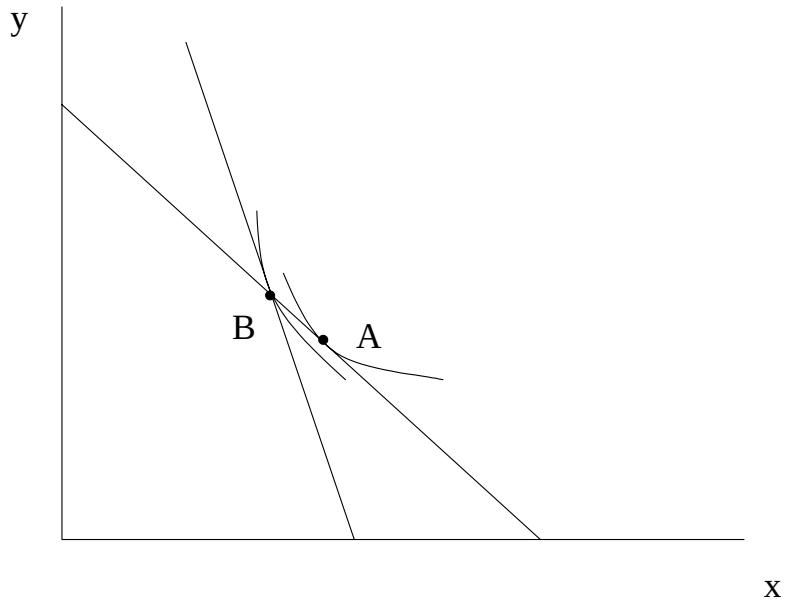

Figure 4:

The denominator:

$$p_{x0}x_{1+}p_{y0}y_1 \geq E(p_{x0}, p_{y0}, U_1)$$

because (x_1, y_1) might allow the consumer to reach the indifference curve U_1 but not in the cheapest way at prices (p_{x0}, p_{y0}).

Hence usually Paasche index understates the chenage in the cost of living relative to the ideal index.

- Case where $P = 1$

[Graph 49]

The new bundle lay on the old budget set, but it wasn't previously chosen so the consumer must be worse off.

Hence these indeces use different relevance utility.
Laspeyres: is old utility available at new prices?
Paasche: is new utility available at old prices?

There is an intermediate index, Tornquist, that reduces bias on average, but no guarantee of getting things exactly right.

Also Fisher's Ideal Index $\sqrt{L \times P}$ should reduce the bias.

The bottom line is that there is no perfect index.

4 Consumer Price Index (CPI)

Approach taken by CPI:

- Fixed market basket of goods (they are changed every 10 years based on detailed sampling of consumption)
  - 44 geographic strata
  - 207 strata of items (e.g. women's shoes, breakfast cereal)
  - 9108 strata total
- Consumption weights are held constant for 10-year intervals.
- Prices are resampled continuously

What type of an index is this. This is a Laspeyres index because we look at the old bundle at new prices.

Recall that 1/3 of Federal Budget Outlays is indexed to the CPI.

As outlined by the Boskin Commission, what are the sources of bias in the CPI?

1. Substitution bias
2. Outlet bias
3. Quality change bias
4. New product bias
5. Formula bias

4.1 Substitution bias

Increases in the cost of living are always overstated by this index because the Laspeyres always assumes that substitution is zero.

The estimate of this bias is 0.3 and it ranges from 0.2 to 0.4.

4.2 Outlet bias

The idea is that products are available at a discount at outlet stores like Costco, Sam's Club. The CPI ignores price changes when consumers switch to outlets.

A number of questions can be raised regarding this bias: What is the assumption that supports this? Why not simply use the lowest price available at any outlet? What is the strongest evidence in favor of the CPI's assumption?

The estimate for this bias is around 0.2 and it ranges from 0.1 to 0.3

4.3 Quality change

The idea behind this bias is that products are constantly improving. Reliability, efficiency, features and convenience on many products like cars, computers, appliances and entertainment are constantly increasing.

How do we separate the part of price change due to quality enhancement vs. price inflation?

CPI tends to

1. not capture quality improvements not associated with price change
2. attribute most price increases to inflation rather than quality improvement

Example: price change of computers. Steady for many years recently but quality enhancements are dramatic. Here we have both quality improvement and price fall.

Counterpoint: what about goods where low quality models no longer exist? Cars used to be substantially cheaper in real terms, but less safe, less reliable, less efficient, less comfortable, less durable.

The estimate for this bias is around 0.2 and it ranges from 0.2 to 0.6

4.4 New products

1. The idea is that it is hard to incorporate new products (VCR, Cellphone, PC, Palm Pilot, Internet, Fax) into price index.

   Ideally it new products would be incorporated in the following way:

   $$\frac{E(p_1, ..., p_n, p_{internet,1}, U_0)}{E(p_1, ..., p_n, p_{internet,0}, U_0)}$$

   with $p_{internet,0} = \infty$ and $p_{internet,1} < \infty$

   The problem is that we need a monetized value of the introduction of the new product, but we don't have the Hicksian demand, so we are not able to measure the shaded area in the graph.

   [Graph 50]

Graph 50

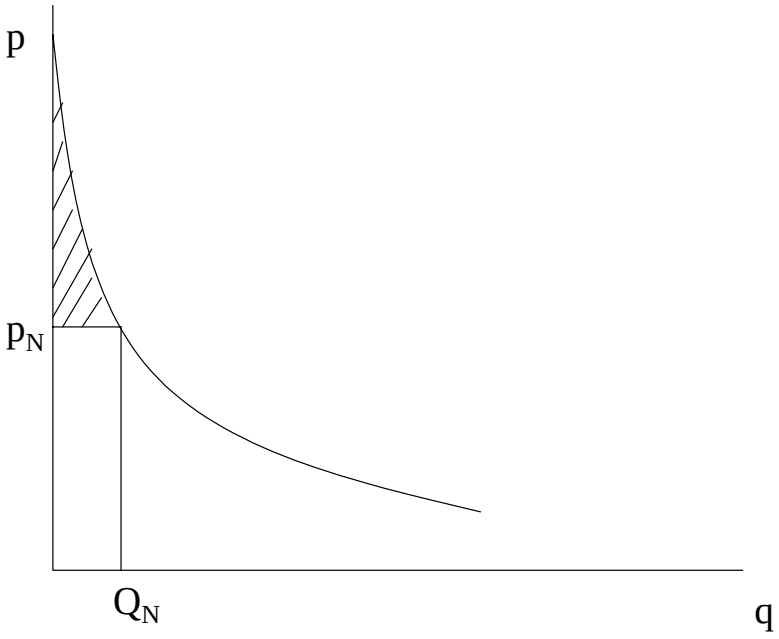

Figure 5:

4.5 Formula bias

This refers to the fact that indeces all approximate the ideal cost of living index.

Conceptual Experiment

Let's think about the following experiment.

We take a basket of goods and services in 1970 with their respective 1970 prices and we take a basket of goods and services in 1999 with their respective 1999 prices.

Then we ask the consumers how much more income they would need in 1999 in order to be as satisfied with the 1999 basket and prices as the 1970 basket and prices.

Since so many good things are unavailable in 1970 you might end up concluding that frankly you needed a lot of money to be as happy in 1970 (though presumably not as much as 1999). If 1999 number is less than 4 times 1970 number, this suggests the CPI is overstated.

The estimate for this bias is 0.2, while it ranges from 0.2 to 0.7.

4.6 Conclusion

The upward bias is estimated at 0.7 to 2.0 per year. According to the commission the bias in CPI is 4th largest government program (behind Social Security, Medicare, Defense) adding $140 billion to deficit and $634 billion to national debt in 2005.