

Deflators and Price Indices

For many students the formulas for deflators and price indices are a form of tedious torture by subscript. The purpose of this page is to improve your gain-to-pain ratio.

In the early days of index numbers the issue was seen as a statistical one: how to average all the individual price changes occurring over a period of time into a single measure of the change in the general price level. While you no doubt are familiar with the simple arithmetic mean, there are considerably more exotic ways of summarizing individual price changes (e.g., geometric means, harmonic means). A further complication is the issue of weighting the individual price changes: a five percent increase in housing rents has more macroeconomic significance than a twenty percent increase in the price of dental floss.

The formulas presented in Chapter 2, pp. 23-25, boil down to the pricing out of some specified market basket of goods at two separate sets of prices. Consider two distinct points in time, b and t , where b is the base period and t is the so-called current period and a simple two-good economy (where a is for apples and o is for oranges).

Work down the lines of the following table noting that the variables are designated with capital letters (P for price and Q for quantity), subscripts designate the time period of the variable (b or t), and superscripts designate the good we are talking about (a or o). Note that certain items are observed and others need to be calculated from observed items.

Common Sense

Inspection of the formulas in lines (21) and (22) reveals that the difference between them is which market basket of apples and oranges happens to be held constant. The deflator uses the period t market basket, whereas the price index uses the market basket from period b .

When you stop and think about it for a moment, it seems rather obvious: *you compute the ratio of the bills for two different price regimes while holding the market basket constant.*

There is no obvious statistical reason for preferring one market basket to the other. And except for the rather special case of the one of the market baskets being a multiple of the other, the two formulas will give you different values for the ratio of the price levels between period t and b .

(1)	P_t^a	Price of apples in period t	observed
(2)	P_b^a	Price of apples in base period b	observed
(3)	Q_t^a	Quantity of apples in market basket of period t	observed
(4)	Q_b^a	Quantity of apples in market basket of base period b	observed
(5)	P_t^o	Price of oranges in period t	observed
(6)	P_b^o	Price of oranges in base period b	observed
(7)	Q_t^o	Quantity of oranges in market basket of period t	observed
(8)	Q_b^o	Quantity of oranges in market basket of base period b	observed
(9)	$P_t^a Q_t^a$	Value of apples in current market basket at current prices	observed
(10)	$P_t^o Q_t^o$	Value of oranges in current market basket at current prices	observed
	(Q_t^a, Q_t^o)	Market basket in current period t	observed
	(Q_b^a, Q_b^o)	Market basket in base period b	observed
(11)	$P_t^a Q_t^a + P_t^o Q_t^o$	Value of current market basket at current prices (nominal spending)	observed (9) + (10)
(12)	$P_b^a Q_t^a$	Value of current apples at base prices	(2) × (3)
(13)	$P_b^o Q_t^o$	Value of current oranges at base prices	(6) × (7)
(14)	$P_b^a Q_t^a + P_b^o Q_t^o$	Value of current market basket at base prices (real spending)	(12) + (13)
(15)	$P_b^a Q_b^a$	Value of apples in base market basket at base prices	observed
(16)	$P_b^o Q_b^o$	Value of oranges in base market basket at base prices	observed
(17)	$P_b^a Q_b^a + P_b^o Q_b^o$	Value of base market basket at base prices	observed (15) + (16)
(18)	$P_t^a Q_b^a$	Value of base apples at current prices	(1) × (4)
(19)	$P_t^o Q_b^o$	Value of base oranges at current prices	(5) × (8)
(20)	$P_t^a Q_b^a + P_t^o Q_b^o$	Value of base market basket at current prices	(18) + (19)
(21)	$\frac{P_t^a Q_t^a + P_t^o Q_t^o}{P_b^a Q_t^a + P_b^o Q_t^o}$	The deflator is nominal spending divided by real spending.	$\frac{(11)}{(14)}$
(22)	$\frac{P_t^a Q_b^a + P_t^o Q_b^o}{P_b^a Q_b^a + P_b^o Q_b^o}$	Price index is ratio of the value of the base market basket at current prices to the original value of the base market basket at base prices.	$\frac{(20)}{(17)}$

Statistical Sense

We can rewrite the formulas for deflator and price index to show that they are actually weighted means of the individual price ratios. **The trick is to multiply and divide by the appropriate prices** so that we end up with a formula in terms of spending shares and price ratios

$$\underbrace{\frac{P_t^a Q_b^a + P_t^o Q_b^o}{P_b^a Q_b^a + P_b^o Q_b^o}}_{\text{price index}} = \underbrace{\left(\frac{P_b^a Q_b^a}{P_b^a Q_b^a + P_b^o Q_b^o} \right)}_{\substack{\text{share of spending} \\ \text{in the base period} \\ \text{on apples}}} \left(\frac{P_t^a}{P_b^a} \right) + \underbrace{\left(\frac{P_b^o Q_b^o}{P_b^a Q_b^a + P_b^o Q_b^o} \right)}_{\substack{\text{share of spending} \\ \text{in the base period} \\ \text{on oranges}}} \left(\frac{P_t^o}{P_b^o} \right)$$

$$\underbrace{\frac{P_t^a Q_t^a + P_t^o Q_t^o}{P_b^a Q_t^a + P_b^o Q_t^o}}_{\text{deflator}} = \frac{1}{\underbrace{\left(\frac{P_t^a Q_t^a}{P_t^a Q_t^a + P_t^o Q_t^o} \right)}_{\substack{\text{share of spending} \\ \text{in period } t \\ \text{on apples}}} + \underbrace{\left(\frac{P_t^o Q_t^o}{P_t^a Q_t^a + P_t^o Q_t^o} \right)}_{\substack{\text{share of spending} \\ \text{in period } t \\ \text{on oranges}}}} \left(\frac{P_b^a}{P_t^a} \right) + \left(\frac{P_b^o}{P_t^o} \right)$$

The price index uses a weighted arithmetic average of the individual price ratios, where the weights are taken from the base period.

The deflator uses a weighted harmonic mean of the individual price ratios (because the ratios are in the denominator, they have been flipped), where the weights are taken from period t .

Economic Sense

Why we care about price levels.

- i) real wage (W/P)
- ii) real money balances (M/P)
- iii) changes in the price level give us the rate of inflation π (of course, different measures of the price level can end up generating different measures of inflation)

Note: the “natural” way to keep income and expenditure accounts and balance sheets is in nominal terms. To obtain real income, real expenditure and real wealth we need to compute an “artificial” measure of the price level in order to convert nominal stocks and flows into real stocks and flows.