



Statistical literacy guide

How to adjust for inflation

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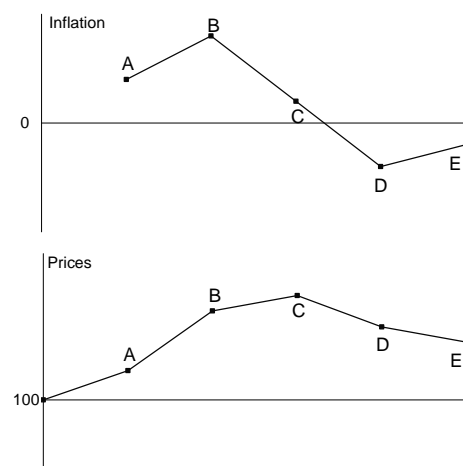
This note uses worked examples to show how to express sums of money taking into account the effect of inflation. It also provides background on how three popular measures of inflation (the GDP deflator, the Consumer Price Index, and the Retail Price Index) are calculated.

1.1 Inflation and the relationship between real and nominal amounts

Inflation is a measure of the general change in the price of goods. If the level of inflation is positive then prices are rising, and if it is negative then prices are falling. Inflation is therefore a step removed from price *levels* and it is crucial to distinguish between changes in the level of inflation and changes in prices. If inflation falls, but remains positive, then this means that prices are still rising, just at a slower rate². **Prices are falling if and only if inflation is negative.** Falling prices/negative inflation is known as deflation. Inflation thus measures the *rate of change* in prices, but tells us nothing about absolute price *levels*.

To illustrate, the charts opposite show the same underlying data about prices, but the first gives the level of inflation (percentage changes in prices) while the second gives an absolute price index. This shows at point:

- A** -prices are rising and inflation is positive
- B** -the level of inflation has increased, prices are rising faster
- C** -inflation has fallen, but is still positive so prices are rising at a slower rate
- D** -prices are falling and inflation is negative
- E** -inflation has increased, but is still negative (there is still deflation), prices are falling at a slower rate (the level of deflation has fallen)



The corollary of rising prices is a fall in the value of money, and expressing currency in real terms simply takes account of this fact. £100 in 1959 is *nominally* the same as £100 in 2009, but in *real* terms the £100 in 1959 is worth more because of the inflation over this period. Of course, if inflation is zero, then nominal and real amounts are the same.

1.2 Using price indices to calculate inflation rates and express figures in real terms

We can use price indices to adjust for inflation and present financial data in real terms (constant prices) or calculate real rather than nominal changes. The guide on [index numbers](#) gives an introduction to indices and briefly explains what they mean.

¹ All statistical literacy guides are available on the Library [Intranet pages](#):

² Conversely, a low, negative (less than zero) inflation rate implies they are falling more slowly, and a highly negative rate implies they are falling more quickly. Negative inflation is often referred to as deflation.

Consecutive years

The example below uses the HM Treasury [GDP deflator](#) index. The table opposite shows this index and the corresponding year-on-year inflation rate.

The inflation rate is the percentage change in the index from one year to the next. For example, inflation between 1999-00 and 2000-01 was

$$\left[\left(\frac{83.051}{81.976} \right) - 1 \right] = 1.31\%^3$$

HMT GDP Deflator figures

Year	Index	Inflation rate
1999-00	81.976	
2000-01	83.051	1.31
2001-02	84.903	2.23
2002-03	87.640	3.22
2003-04	90.138	2.85
2004-05	92.589	2.72
2005-06	94.485	2.05
2006-07	97.030	2.69
2007-08	100.000	3.06

Since prices in 2000-01 were 1.31% higher than in 1999-00, to convert £100 from 1999-00 to 2000-01 prices (make the inflation adjustment) we multiply by $1 + [\textit{inflation rate}]$, which in this case is:

$$£100 * (1 + 0.0131) = £101.31$$

Essentially, this calculation tells us that in 2000-01, we would need £101.31 to buy the same real value of goods that £100 would have bought in 1999-00. We do not always need to explicitly calculate the inflation rate. A shortened version of this calculation divides the £100 by the 1999-00 index and multiplies by the 2000-01 index:

$$£100 * \left(\frac{83.051}{81.976} \right) = £101.31$$

Clearly, the inflation rate depends on which goods one buys; some may have fallen and others risen in price during the year. This is why the distinction between different types of index is important, since they measure the price changes of different sets of goods and/or services. This is dealt with in Section 2.

Non-consecutive years

In 2001-02, inflation was 2.23%, so to express our £100 from 1999-00 in 2001-02 prices, we take the £101.31 from 2000-01 and perform the same calculation; namely

$$£101.31 * (1 + 0.0223) = £103.57$$

What about expressing £100 in 2007-08 prices? Clearly, applying our current method will involve six more tiresome calculations. This is where the index is useful. If inflation between

1999-00 and 2000-01 was $\left[\left(\frac{83.051}{81.976} \right) - 1 \right]$, then total inflation between 1999-00 and 2007-08

is $\left[\left(\frac{100}{81.976} \right) - 1 \right] = 22.0\%$

and more generally, inflation between years y and x is

³ N.B. 1.31% = 0.0131 50% = 0.5 2000% = 20 etc.

$$\left[\left(\frac{\text{index.number.for.year..x}}{\text{index.number.for.year..y}} \right) - 1 \right], \text{ bearing in mind that x is further ahead in time than y.}$$

With a total 22.0% inflation between 1999-00 and 2007-08, we can express our £100 in 2007-08 prices by multiplying by $[1 + \text{the inflation rate}]$ as usual:

$$£100 * 1.22 = £122$$

Again we can shorten this calculation if we do not need to explicitly calculate the inflation rate. In general to express a value from year y in year x prices:

$$\text{Year y value} * \left(\frac{\text{index.number.for.year..x}}{\text{index.number.for.year..y}} \right) = \text{year y value in year x prices}$$

Note that an index number on its own does not signify anything; it is only meaningful in relation to another index number.

1.3 Constructing a real time series and calculating real changes

Often we want to express a series of actual (nominal) values in real terms. This involves revaluing every annual figure into a chosen year's prices (a base year), effectively repeating the stages above on a series of nominal values and using the same base year (year x above) for all. Whilst this does mean making as many calculations as there are years to be revalued, this is a very simple task in a spreadsheet. Once done, changes can be calculated in percentage or absolute terms. The choice of base year does not affect percentage change calculations, but it will affect the absolute change figure, so it is important to specify the base year.⁴

1.4 Internal purchasing power

Expressing changes in a currency's purchasing power (the quantity of resources a set amount can buy) is essentially the opposite process to expressing an amount in real terms. To express a figure in real terms, we *multiply* by $[1 + \text{the inflation rate}]$; to express the purchasing power of an amount, we *divide* by $[1 + \text{the inflation rate}]$.

Using the previous example, if the purchasing power of £1.00 is 100 pence in 1999-00, in 2007-08 its purchasing power is $\frac{1}{1.22} = £0.82$ (i.e. purchasing power fell 18%).

Once again, the price index used has important implications for the interpretation of the result. Like changes in prices, changes in individuals' purchasing power are idiosyncratic, and figures derived from the GDP deflator merely reflect economy-wide average changes.

2 Different price indices

2.1 Overview

A price index is a series of numbers used to show general movement in the price of a single item, or a set of goods⁵, over time. Thus, insofar as every good has a price that changes

⁴ For instance we can say 'a 5% real increase' without a base year, but 'a £5 million real increase' needs a base year specified, since if prices are rising, a later base year will give us a higher figure and *vice versa*. It is good practice to use the latest year's prices as the base year.

⁵ Hereon, the expression 'goods' encompasses both goods and services

over time, there are as many inflation 'rates' as there are different groupings of goods and services. When the media talk about 'personal inflation rates', they are referring to changes in the prices of things that a particular individual buys.

In general, any price index must consist of a set of prices for goods, and a set of corresponding weights assigned to each good in the index.⁶ For consumer indices, these weights should reflect goods' importance in the household budget; a doubling in the price of chewing gum should not, for instance, affect the index as much as a doubling in energy bills.

2.2 The GDP deflator

The GDP deflator measures the change in price of all domestically produced goods and services. It is derived by dividing an index of GDP measured in current prices by a constant prices (chain volume) index of GDP. The GDP deflator is different from other inflation measures in that it does not use a subset of goods; by the definition of GDP, all domestically produced goods are included. In addition, there is no explicit mechanism to assign importance (weights) to the goods in the index; the weights of the deflator are implicitly dictated by the relative value of each good to economic production.

These unique features of the GDP deflator make its interpretation slightly less intuitive. Whilst consumer/producer inflation indices reflect average change in the cost of goods typically bought by consumers/producers, the GDP deflator is not representative of any particular individual's spending patterns. From the previous example, a possible interpretation could be as follows: suppose in 1999-00 we spent the £100 on a tiny and representative fraction of every good produced in the economy; then the GDP deflator tells us that we would need 1.31% more money (£101.31) to buy that same bundle in 2000-01.

The GDP is normally used to adjust for inflation in measures of national income and public expenditure where the focus is wider than consumer items alone. The [Treasury indices](#) give financial years only, but it can be calculated for calendar years or quarters.

2.3 The Consumer Price Index (CPI) and the Retail Price Index (RPI)⁷

The ONS publishes two measures of consumer price inflation: the CPI and the RPI⁸. Each is a composite measure of the price change of around 650 goods and services on which people typically spend their money. The most intuitive way of thinking about the CPI/RPI is to imagine a shopping basket containing these goods and services. As the prices of the items in the basket change over time, so does the total cost of the basket; CPI and RPI measure the changing cost of this basket.

A 'perfect' consumer price index would be calculated with reference to all consumer goods and services, and the prices measured in every outlet that supplies them. Clearly, this isn't practicable. The CPI/RPI use a representative *sample* of goods and the price data collected for each good is a *sample* of prices: 'currently, around 120,000 separate price quotations are used... collected in around 150 areas throughout the UK' (ONS, 2008).

RPI and CPI data can both be downloaded from the ONS [Consumer Price Indices](#) release. The RPI is commonly used to adjust for inflation faced by consumers. It is also used as a basis to uprate many state benefits and as the normal interest rate for student loans.

⁶ Clearly, when charting just one price, there is no need for weighting, since the good assumes complete importance in the index.

⁷ Differences between the CPI and the RPI are not considered in this note; broadly they arise from differences in formula and coverage. Some further background is given in the standard note on the [Retail Prices Index](#)

⁸ Another commonly-used index, the RPIX, simply excludes mortgage interest payments from the RPI

2.4 Selection of items and application of weights in the CPI/RPI

Some items in the CPI/RPI are sufficiently important within household budgets that they merit their place in the basket *per se*: examples include petrol, electricity supply and telephone charges. However, most goods are selected on the basis that changes in their price reflect price changes for a wider range of goods. For instance, the CPI contains nine items which together act as ‘bellwethers’ for price change in the ‘tools and equipment for the house and garden’ class.

The 2008 CPI classes and the weights assigned to them are shown in the table below, alongside the proportion of representative items assigned to each class. The number of items assigned to a class depends on its weight in the index, and the variability of prices within the class; for instance, tobacco has only five items whilst food has over a hundred.

CPI allocations, 2008

Class	Weight in CPI index	Percentage of total representative items
01 Food and Non-Alcoholic Beverages	10.9%	22%
02 Alcoholic Beverages and Tobacco	4.2%	4%
03 Clothing and Footwear	3.6%	11%
04 Housing, Water, Electricity, Gas and other fuels	11.5%	5%
05 Household Furnishings, Equipment and maintenance	6.7%	11%
06 Health	2.2%	3%
07 Transport	15.2%	6%
08 Communications	2.3%	1%
09 Recreation and Culture	15.2%	17%
10 Education	1.9%	1%
11 Restaurants and Hotels	13.7%	8%
12 Miscellaneous Goods and Services	9.9%	11%

Each year, the weights and contents of the basket are reviewed, and alterations are made to reflect changing patterns of consumer spending. Spending changes may arise from substitution in the face of short-term price fluctuation or changing tastes (e.g. butter to margarine), or from the development of new goods. For example, in 2008 35mm camera films were replaced by portable digital storage media. In total, eight items were dropped from the CPI/RPI in 2008, including CD singles, lager ‘stubbies’ and TV repair services.

3 Further calculations using monthly CPI/RPI data

The table opposite shows monthly RPI data for 2007 and 2008, and is used as a reference point for the following examples.

3.1 Calculating inflation between specific months

This is done in precisely the same way as for annual data. Inflation between Dec 2007 and Dec 2008 is simply

$$\left[\left(\frac{212.9}{210.9} \right) - 1 \right] = 0.95\%$$

3.2 Calculating average annual inflation

This might be done in order to convert the RPI series into an annualised format (e.g. for direct comparison with the GDP deflator). The principle is once again the same, but rather than take specific index numbers twelve months apart, we use the arithmetic mean (average) of the twelve index numbers in each year.

Monthly RPI index
Jan 2007 to Dec 2008

Year, month	Index
2007 01	201.6
2007 02	203.1
2007 03	204.4
2007 04	205.4
2007 05	206.2
2007 06	207.3
2007 07	206.1
2007 08	207.3
2007 09	208.0
2007 10	208.9
2007 11	209.7
2007 12	210.9
2008 01	209.8
2008 02	211.4
2008 03	212.1
2008 04	214.0
2008 05	215.1
2008 06	216.8
2008 07	216.5
2008 08	217.2
2008 09	218.4
2008 10	217.7
2008 11	216.0
2008 12	212.9

Let I_{07} equal the average of the twelve monthly index numbers in 2007, and I_{08} the average of the monthly index numbers in 2008.

Then average annual inflation between 2007 and 2008 = $\left[\left(\frac{I_{08}}{I_{07}} \right) - 1 \right] = 3.99\%$

3.3 Calculating average annual inflation over periods other than a year

This can be done using the following formula:

$$\left[\left(\frac{I_x}{I_y} \right)^{\frac{12}{n}} - 1 \right]$$

Where n is the number of months in the period in question, I is the index number, and x is further ahead in time than y .

So, the average annualised rate of RPI inflation for the second half of 2008 is:

$$\left[\left(\frac{212.9}{216.5} \right)^2 - 1 \right] = -3.38\%$$

In calculating average annual inflation over short periods, the ONS offers the following caveat:⁹

It should be noted that this may produce misleading results for just one or two months' change in the index. One reason is that the month-to-month change includes a seasonal component. Another is that some prices change only infrequently, perhaps only once a year. Hence a comparison between different years' annual average indices, or at least between the same month in different years, is to be preferred.

Other statistical literacy guides in this series:

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- [How to adjust for inflation](#)

⁹ ONS Consumer Price Indices Technical Manual – 2007 edition