Methods explained

Methods explained is a quarterly series of short articles explaining statistical issues and methodologies relevant to ONS and other data. As well as defining the topic areas, the notes explain why and how these methodologies are used. Where relevant, the reader is also pointed to further sources of information.

The GDP implied deflator

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SUMMARY

This article will introduce readers to the concept of the gross domestic product (GDP) implied price deflator. The GDP implied deflator is used to measure changes in the overall level of prices for the goods and services that make up GDP. It is an important indicator in the National Accounts as it distinguishes output growth that comes about due to volume increase and that due to price changes. In effect, the GDP implied deflator illustrates how much of the change in nominal GDP from one year to another reflects changes in the price level. It is referred to as the implied deflator: for example, if GDP increases by 2 per cent in real terms and 5 per cent in nominal terms, the implied economy-wide rate of inflation is 3 per cent.

Two different measurements are used to calculate the gross domestic product (GDP) growth rate attributable to volume and price changes:

- current (nominal) GDP – measures value of transactions in the prices relating to the period being measured and is both a volume and price indicator, and
- constant (real) GDP – measures relative changes in the volume of goods and services between one period and another

The ratio of the current to constant price series is a measure of price movements, and this forms the basis for the calculation of the implied GDP deflator.

The GDP of a country can be measured in three ways: the output, expenditure and income approach. It is defined as the total market value of all final goods and services produced within a country in a given period of time.[1]

So, why is the distinction between output growth from changes in volume and changes in prices important? If output growth is due to an increase in prices, but volumes have remained the same, then changes in GDP are not due to economic growth. By taking away the price effects of output growth, that is, by deflating, one can obtain the 'real' measure of GDP growth. This central economic issue can be illustrated in the simple example in **Box 1**. For simplicity's sake, a closed economy is one that is assumed to produce just two goods, clothes and food.

As illustrated in the worked example, it is difficult to see how much the growth rate in GDP has come about due to changes in the volume of output or price. This has obvious implications for measuring growth from one year to the next, as it means that changes in GDP may not necessarily mean that the economy is growing. If, for example, in year three, the price of clothes increases to £3 and the quantities produced remain the same from year two, the GDP growth rate in overall nominal terms will show a 41 per cent increase. While the market value of the goods and services produced by the country has increased, the volume of goods and services produced has not.

This methodology article will go on to show how the GDP deflator is

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Box 1
Simple growth rate calculation

Year	Price of clothes	Quantity of clothes	Price of food	Quantity of food
1	£1.00	50	£3.00	300
2	£2.00	100	£3.00	500
3	£3.00	100	£3.00	700

GDP is simply the sum of P (price) times Q (quantity), with i being the particular product. For example:

$$\sum P_i Q_i = GDP \ (£1 \times 50) + (£3 \times 300) = £950 = (GDP)$$

To calculate the nominal GDP growth rate, GDP for the second year is divided by GDP for the first year, and then one is subtracted as follows then multiplied by hundred. For example, in this case, the GDP growth rate from year one to year two would be 79 per cent in nominal terms:

$$GDP \ growth \ rate = \frac{[GDP_2]}{[GDP_1]} - 1 \times 100 \quad \text{i.e.} \quad \frac{1700}{950} - 1 \times 100 = 79\%$$

calculated; explain briefly volume derivation; explain how the GDP deflator compares with the retail prices index – all items excluding mortgage interest payments (RPIX); and finally how the GDP deflator will be related to recent UK experience.

The construction of the GDP implied deflator

This section will illustrate how the GDP implied deflator is derived using a basic equation. It will then develop this to show how, using a simple example, the Office for National Statistics (ONS) obtains its current and constant price volume measures and deflator.

The basic equation for deriving the GDP deflator is shown below:

$$\text{GDP implied deflator} = \frac{\text{current price (CP)}}{\text{constant prices (KP) volume}} \times 100$$

The implied GDP deflator is simply the current price divided by the constant price volume measure.

ONS uses the Laspeyres index to obtain the constant price volume of growth and is represented by the following equation, where P denotes price and Q quantity, P_0 and Q_1 relates to current prices and quantity in year one and $P_0 Q_0$ is the summation of volume in year two at base prices:

$$L = \frac{\sum P_0 Q_1}{\sum P_0 Q_0}$$

The Laspeyres index is used to calculate volume growth between two periods; it compares the sum of goods and services in the first (or base) period, weighted by a given price structure, with the sum of the physical units in the second period, weighted by the same price structure. This in effect takes out the variation in prices between the two periods, thus capturing purely the volume effect. This is then chain linked (see Robjohns 2006).

The derivation of the GDP implied deflator can be illustrated using the simple example in **Box 2**.

Derivation of volume measures

The derivation of volume measures can be either market or non-market based: market-based volume measures are a form of direct deflation. Price indices, such as the producer price indices or the consumer price indices, are primarily used in deflating consumption expenditure, that is, food and services. Non-market output (output that is provided free) applies in situations where price measurement does not seem possible or feasible. This can be divided into two types:

- individual goods and services – those that are consumed by households such as on education and health, and
- collective services – where services are provided to society as a whole, for example, public administration and defence

For both these categories, output is hard to define. With regard to collective services, there is no transaction between producer and consumer. Without prices for the output, there are only two options for constant price measurement: deflating inputs, and direct volume measurement. Measuring prices and volumes for non-market output at current prices is defined as the sum of costs minus revenues. In an input method, the output in constant unit costs is approximated by deflating the current year costs or extrapolating base-year costs.

The GDP implied deflator versus the retail prices index

The implied GDP deflator and the retail prices index (RPIX) are both measures of inflation. However, there are differences, with the main ones highlighted in **Box 3**.

Box 2
Deriving the GDP implied deflator using the Laspeyres chained volume index

	A	B	C
1			Year
2		0	1
3	**Prices**		
4	Good 1	50	60
5	Good 2	40	50
6	**Quantities**		
7	Good 1	100	200
8	Good 2	200	300
9	**Nominal GDP**	13,000	27,000
10	Index at nominal prices		208
11	Real growth rate of output (Laspeyres index) (previous year's prices used as weights) i.e. $\sum P_0 Q_1$	13,000	22,000
12	Laspeyres volume index		169
13	Volume index obtained by deflation		123

First sum 50 x 100 (B4 x B7) + 40 x 200 (B5 x B8) = 13,000 (B9). Then sum 60 x 200 (C4 x C7) + 50 x 300 (C5 x C8) = 27,000 (C9). Dividing 27,000 by 13,000 (C9/B9) x 100, the current price index of 208 is obtained.

To calculate the Laspeyres index, $\sum P_0 Q_0$ is first derived, which relates to the current prices for year zero, that is, 13,000. The current volumes for year one at year zero prices is $\sum P_0 Q_1$, 200 x 50 + 300 x 40 = 22,000. The volume index is calculated between the two periods by dividing 22,000 by 13,000 (C11/ B11) x 100 = 169 (C12).

To obtain the deflator, the current price index is divided by the Laspeyres volume index – divide 208 by 169 (C10/C12) x 100 = GDP implied deflator =123 (C13), so prices have risen by 23 per cent.

Box 3		
Comparison between the GDP implied deflator and RPIX		
Differences	GDP implied deflator	RPIX
Measures	Indirect measure of inflation – derived from sub-components of the National Accounts that are either deflated at a low level with a few (in particular government) based on direct measures of output then aggregated.	Direct measure of inflation – compiled from the prices of goods and services provided by businesses to households. Measures consumer prices.
Coverage	Is a broad measure of inflation. The GDP deflator reflects price movements in all aspects of the economy including household spending, government spending, investment and net trade. It is a weighted average of these price effects including negative weights for imports.	Applies to goods and services consumed by households.
Weighting	Is current weighted, reflecting changes in prices and expenditure weights, that is, current spending patterns. Since the weights reflect the composition of GDP in each period, changes in the index reflect movements in both prices andthe composition of GDP.	Compares the prices of a constant basket of goods and services between any two periods. Is base weighted.

Figure 1
Comparison in growth rates between the GDP deflator and RPIX

Percentage change, quarter on quarter
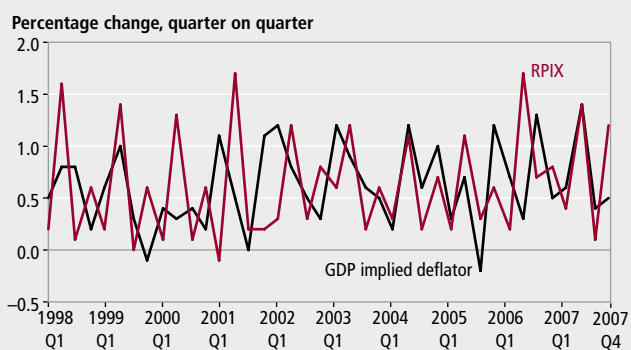
In principle, there should be little difference between the GDP deflator and RPIX, as both measure average changes in prices. **Figure 1** shows that, empirically, the GDP deflator and RPIX tend to exhibit similar trends. Any differences between the GDP deflator and the RPIX can largely be accounted for by price movements in goods and services traded abroad and government output.

The recent UK experience

Column A in **Table 1** shows the money value of UK economic output (GDP) which reflects changes in both output and prices. The next two columns disentangle these factors. Column B shows the volume of output with all goods and services measured in 2003 prices and by definition are equal to GDP at current prices. Column C indicates the path of inflation, that is, the deflator.

Figure 2 gives a time series graphical presentation of the UK

Table 1
### Current, constant and deflator index series

	Current prices (£ million)	Constant prices (£ million)	Price deflator index (2003=100)	Current prices index (2003=100)	Constant prices index (2003=100)
	A	B	C	D	E
1987	421,559	757,452	55.7	37.7	67.7
1988	470,748	795,317	59.2	42.1	71.1
1989	517,075	812,725	63.6	46.2	72.7
1990	560,887	819,007	68.5	50.2	73.2
1991	589,739	807,814	73.0	52.7	72.2
1992	614,776	809,540	75.9	55.0	72.4
1993	645,500	827,886	78.0	57.7	74.0
1994	684,067	863,623	79.2	61.2	77.2
1995	723,080	889,041	81.3	64.7	79.5
1996	768,905	913,800	84.1	68.8	81.7
1997	815,881	942,154	86.6	73.0	84.3
1998	865,710	973,748	88.9	77.4	87.1
1999	911,945	1,003,370	90.9	81.6	89.7
2000	958,931	1,041,517	92.1	85.8	93.1
2001	1,003,297	1,066,217	94.1	89.7	95.3
2002	1,055,793	1,088,108	97.0	94.4	97.3
2003	1,118,245	1,118,245	100.0	100.0	100.0
2004	1,184,296	1,154,685	102.6	105.9	103.3
2005	1,233,976	1,175,916	104.9	110.3	105.2
2006	1,303,915	1,210,288	107.7	116.6	108.2
2007	1,384,823	1,246,895	111.1	123.8	111.5

Source: Office for National Statistics

current and volume price series data. The GDP implied deflator can be simply inferred as the relative gap between the two. It can be deduced from the graph that:

- nominal GDP has risen in every year since 1987
- the deflator has also risen in every year since 1987, and
- constant price GDP has increased in every year since 1987, except between 1990 and 1991

Table 1 shows that the value of output rose between 1990 and 1991 (from £560.9 billion to £589.7 billion), although at prices ruling in 1990, real output fell over the same period (from £819.0 billion to £807.8 billion) – referenced to 2003 base year prices.

Figure 2
UK GDP inflation experience
£ billion
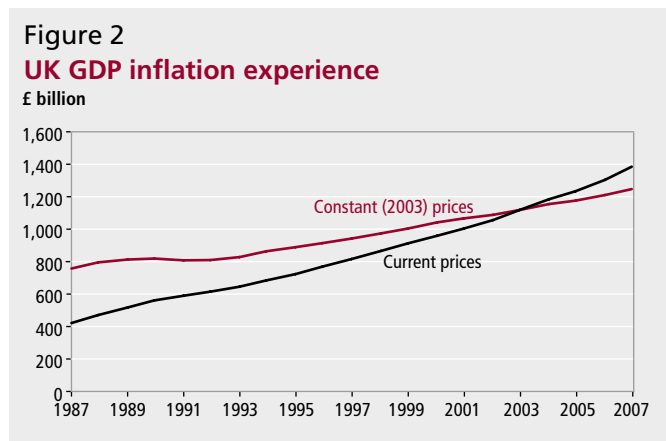
Notes

1 The standard definition is enshrined in the international reference manual, the System of National Accounts 1993 (SNA 93), where GDP is defined as 'the sum of the gross values added of all resident producers at basic prices, plus all taxes less subsidies on products'.

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