

Methodology Notes: Annual chain-linking

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Office for National Statistics

This is the latest article in a new series called 'Methodology Notes'. This series aims to explain statistical issues relevant to our data in a simple, non-technical way. As well as defining the topic areas, the notes explain when, why and how these methodologies are used within the Office for National Statistics (ONS). Where possible, we also point the reader to further sources of information.

What is annual chain-linking?

In the UK, GDP is estimated using three different approaches: output, expenditure and income, which are then balanced to produce a single estimate. Volume measures for both the expenditure and output measures of GDP are aggregated up from the volume measures of their components. Up until 2003 the volume measures were aggregated using a 'fixed-base' methodology. This meant that until 2003, each component volume measure was weighted using its value share of the whole economy in 1995. For earlier time periods, the value shares from 1990, 1985, 1980 and so on were used. The five-yearly updating of weights is called rebasing, which caused revisions.

In terms of accuracy, this methodology was less than ideal, as it assumed the value shares of goods in the economy did not change for five years. The UK has a dynamic economy so that goods change in importance over short periods of time (for example, fast-moving electrical goods such as computers, cameras and mobile phones). It is likely that the assumption of goods having fixed values over five years is flawed. Consequently, ONS desired a methodology that would update the weights more frequently, so the output and expenditure measures truly reflected what was happening in the changing economy.

Annual chain-linking is a method for aggregating the volume measures on a more frequent basis. It can be thought of as rebasing every year. Instead of referring back to value shares from the most recent base year, volume measures for each year are produced in prices of the previous year. These volume measures are then 'chain-linked' together to produce a continuous time series.

How is annual chain-linking done in ONS?

Figure 1 shows how the fixed-base and annual chain-linking methodologies differ in their treatment of the data. In this example we have a simplified economy with two goods, A and B. The steps taken to produce the fixed-base and chained volume measures are demonstrated. The value shares are calculated simply by the quantity of the good multiplied by its current or constant price.

Step 1

Fixed-base expenditure – calculate the values for each year using the base year prices. In the year before a base change, calculate values for both the old and new base prices.

Annual chain-linking – calculate the values for each good in current prices and previous years' prices.

Figure 1

Data																																																																																																																																																											
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Step 2

Fixed-base expenditure – aggregate for all goods for the old and new base years.

Annual chain-linking – aggregate for all goods for current and previous years' prices.

Step 3

Fixed-base expenditure – use the link year to reference all the previous values to the new base year.

Annual chain-linking – link each year to the previous year and reference all values to a chosen year.

Fixed-base expenditure

Using the figures from the example, the move from the old base year to the new base year is linked using the 1994 values at 1990 base prices and 1995 base prices. This is shown by the calculations below:

$$\frac{(1994 \text{ value at } 1995 \text{ prices}) / (1994 \text{ value at } 1990 \text{ prices}) = {}_{94}V_{95} / {}_{94}V_{90} = 1,807 / 2,169 = \mathbf{0.833}$$

$${}_{93}V_{95} = {}_{93}V_{90} \times 0.833 = 1,931 \times 0.833 = \mathbf{1,609}$$

$${}_{92}V_{95} = {}_{92}V_{90} \times 0.833 = 1,764 \times 0.833 = \mathbf{1,470}$$

$${}_{91}V_{95} = {}_{91}V_{90} \times 0.833 = 1,621 \times 0.833 = \mathbf{1,350}$$

$${}_{90}V_{95} = {}_{90}V_{90} \times 0.833 = 1,494 \times 0.833 = \mathbf{1,244}$$

Annual chain-linking

The chained volume measure uses the same principle but essentially uses a different base each year:

$${}_{95}V_{95} = \mathbf{1,997}$$

$${}_{94}V_{95} = ({}_{95}V_{95} / {}_{95}V_{94}) \times {}_{94}V_{94} = 1,997 / 2,080 \times 1,881 = \mathbf{1,806}$$

$${}_{93}V_{95} = ({}_{94}V_{95} / {}_{94}V_{93}) \times {}_{93}V_{93} = 1,806 / 1,952 \times 1,742 = \mathbf{1,612}$$

$${}_{92}V_{95} = ({}_{93}V_{95} / {}_{93}V_{92}) \times {}_{92}V_{92} = 1,612 / 1,804 \times 1,651 = \mathbf{1,474}$$

$${}_{91}V_{95} = ({}_{92}V_{95} / {}_{92}V_{91}) \times {}_{91}V_{91} = 1,474 / 1,706 \times 1,568 = \mathbf{1,355}$$

$${}_{90}V_{95} = ({}_{91}V_{95} / {}_{91}V_{90}) \times {}_{90}V_{90} = 1,355 / 1,621 \times 1,494 = \mathbf{1,249}$$

In this example, annual chain-linking has altered the values before 1995. It has also had a corresponding effect on growth rates. The important point to note here is that the revisions to growth rates are not predictable. Here they have been revised upwards once and downwards three times in the five year period. This stems from the fact that there is both a volume and price effect on the weighting of goods in the chained volume measure. There would be a volume effect where updating the weights would tend to increase growth rates because higher weight is given to components which are growing faster. However, there is also a price effect if the price of items with fast growth is falling quickly, which would tend to reduce the weight. Here, good A is increasing quickly in volume but decreasing in price. We could draw comparisons here with high technology goods such as personal computers or mobile phones that have seen a vast increase in quality and sales but stable, or falling, prices.

While volume growth is estimated using chained volume measures, this is not the case in the most recent years. Essentially a fixed-base tail exists at the end of each series using the weights from the chosen base year. In the UK National Accounts this base year is the same as the reference year used to present series. For the *2005 Blue Book* the base year and reference year was 2002. Consequently, this year is used to weight the series from the first quarter of 2003. However, each year this reference year is advanced so, for example, the reference year for *Blue Book 2004* was 2001. Advancing this base year may hence cause some revisions to the growth estimates in the tail of each series.

What effect has annual chain-linking had?

Annual chain-linking has now been used in the National Accounts to provide chained volume measures for several series including GDP, household final consumption expenditure, gross fixed capital formation and trade estimates. These estimates were published for the first time in *Blue Book 2003*. Tuke (2003) shows that the GDP growth rate revisions due to annual chain-linking have been fairly small but there have been moderate reductions in the growth of household final consumption expenditure. While the move to annual chain-linking has caused these one-off revisions, the move away from fixed-base methods ensures that revisions will generally be smaller each year because the weights are updated one year at a time rather than every five years.

Further reading

Ruffles D and Tuke A (2002) The effect of annual chain-linking on components of the expenditure measure of GDP. *Economic Trends* No. 587, pp 39–43. www.statistics.gov.uk/cci/article.asp?ID=202

Soo A and Charmokly Z (2003) The application of annual chain-linking to the Gross National Income system. *Economic Trends* No. 593, pp 41–47. www.statistics.gov.uk/cci/article.asp?ID=329

Tuke A (2002) Analysing the effects of annual chain-linking on the output measure of GDP. *Economic Trends*, No. 581, pp 26–33. www.statistics.gov.uk/cci/article.asp?ID=136

Tuke A (2003) The effect of annual chain-linking on Blue Book 2002 annual growth estimates. *Economic Trends* No. 593, pp 29–40. www.statistics.gov.uk/cci/article.asp?ID=328

Tuke A and Reed G (2001) The effects of annual chain-linking on the output measure of GDP. *Economic Trends* No. 575, pp 37–53. www.statistics.gov.uk/cci/article.asp?ID