

The effects of annual chain-linking on the output measure of GDP

Amanda Tuke
National Accounts Co-ordination Division
Office for National Statistics

Geoff Reed
Short-term Output Indicators Division
Office for National Statistics

e-mail: chain.linking@ons.gov.uk

National Statistics customer enquiry line: +44 (0)845 601 3034

Overview

The Office for National Statistics will be introducing annually chain-linked volume measures to the United Kingdom National Accounts with the *Blue Book* 2003 edition. This will improve the quality of growth estimates and is in line with developments in other countries in the European Union. A system has been developed for the output measure of Gross Domestic Product, implementing annual chain-linking at a detailed level in the Standard Industrial Classification (SIC). For the purpose of this article, value added weights for years other than 1995 have been constructed using information from the industry breakdown available in UK Input-Output Supply and Use Tables and from other sources. The resulting growth estimates based on annual chain-linking are compared with the fixed base estimates (1995=100) published in *Blue Book* 2001. The comparisons suggest that annual chain-linking will cause estimates of the overall growth of GDP, measured by industry, to be revised slightly downwards. One presentational issue for users will be the loss of additivity for all but the most recent years of annual estimates.

Introduction

Annual chain-linking is a method for aggregating the volume measures which are used to estimate economic growth. An accurate estimate of economic growth, embodied by the estimate of Gross Domestic Product (GDP) in constant prices, is important to help determine the effectiveness of economic policy and allow comparisons between countries¹. In the UK, GDP is estimated using three different approaches (output, expenditure and income) which are then "balanced" to produce a single GDP estimate. This article investigates the effects of introducing annual chain-linking as a methodology, requiring more up-to-date, and hence more relevant weights to aggregate volume measures, in this case for the output measure of GDP or GDP(O).

The next section describes the current fixed base methodology and some of its limitations. Then annual chain-linking is described with the benefits of introducing this methodology and the issues for users. The remainder of the article describes the approach used for calculating an annual chain-linked output measure GDP for annual estimates and shows a comparison of annual chain-linked estimates with published fixed base estimates. The terminology for describing

aspects of the calculation of volume measure growth are not applied consistently across sources, so clarification has been provided (see Box 1).

Current methodology

To calculate the output measure of GDP(O), data from each industry are collected to reflect the volume growth in Gross Value Added (GVA)^{2,3}. Industry level estimates, in the form of indices referenced to 100, are aggregated using GVA weights (see Box 2). The "base" year used for the weights is updated at five-yearly intervals to give a new structure of weights and a link year is used to join the indices with the latest weight structure to indices weighted with earlier weight structures. This linking process is carried out by treating the ratio of indices in the link year as a link factor, which is then used to re-scale all previous indices. The most recent "base" year used for the weights is also used as the indexing reference year⁴.

A similar process is carried out for the constant price expenditure measure of GDP, although, in this case, volume growth is represented by constant prices in £ million.

Box 1

Some Helpful Terminology

'Fixed Base': the term used to describe the present basis of constant price National Accounts estimates. As the description of the method makes clear, the present National Accounts estimates are actually chain-linked and the term 'fixed base' is used here as an abbreviation for 'fixed base chain-linking' as linking still occurs between series weighted with weights from different base years.

'Chain-linking': used to refer to the improved method of annual chain linking explained here.

'Weight' (and 'weighting'): these terms are usually used in GDP(O) to describe how important an industry is to the whole economy (in terms of its Gross Value Added). The 'weight' of an industry is usually given as so many 'parts per thousand' of the whole economy.

'Growth': used for simplicity in this discussion of economic change; contraction does occur.

Box 2

Weights for the output measure of GDP

- Weights used for aggregating components of GDP(O) reflect the contribution of each industry to the overall economy in current prices.
- Detailed weights are calculated from a breakdown of GVA totals produced by the ONS in Current Price Input-Output tables Supply and Use Tables¹² together with other more detailed information.
- For 'fixed base' estimates, detailed weights are re-calculated every five years.
- Volume measures now published for 1994 to 2000 in *Blue Book 2001*⁴ use the weight structure in 1995, and are referred to as being at "1995 prices".

Constant Price estimates in £million for the expenditure measure of GDP

- Volume measures for expenditure are represented in constant prices £mill.
- Constant Prices in £mill are made up of two components: volume measure indices and current prices in the most recent base year, currently 1995.
- For estimates for years including and subsequent to the most recent link year, constant prices in £mill are effectively pre-weighted volume measure indices.

Limitations of current methodology

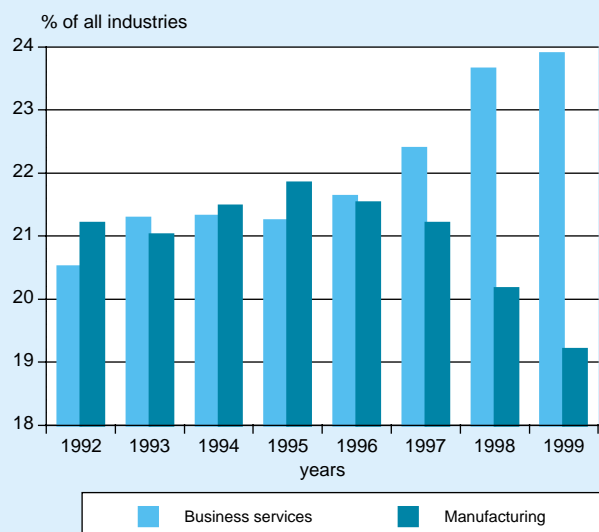
A number of problems are considered to exist with fixed base estimates⁵.

- For industries where the contribution to overall GVA is changing rapidly, a volume measure with a weight from several years before would be "over-weighted" if price fall was steeper than volume growth or volume contraction was steeper than price increases. The volume measure would be "under-weighted" if price fall was less steep than volume growth or vice versa. Estimates published in UK Input-Output Supply Use Tables show that GVA weights do change significantly over time (see Figure 1). This is most likely to be an issue as we enter times of increasingly rapid technological change and the rate of change of weights speeds up.
- Five-yearly rebasing can result in big revisions to estimates.
- For most industries, turnover is used as a proxy for GVA, the assumption being that the turnover to GVA ratio changes little over time. The assumption becomes less valid as time passes.
- When the fixed base year is updated, choosing a link year is a subjective process and the "best" link year will differ from one industry group to another.
- Operations which occur on a five year basis are hard to manage and resource.

Annual Chain-linking

The *System for National Accounts 1993 (SNA93)*¹ recommended that "chained indices" should be used (linking volume growth between consecutive time periods) if the objective is to measure the actual movement of volumes from period to period. The potential benefits

Figure 1
Gross Value Added weights for two major industry groups, Manufacturing and Business services (including Financial Intermediation).



of moving to annual chain-linking have long been recognised in the UK⁶.

Chain-linked indices differ from fixed base indices in that the growth from one year to the next is estimated by weighting the components using the contribution to current price GVA (or weight) in the immediately preceding year (effectively rebasing every year). This series of annually re-weighted annual growths is then 'chain-linked' to produce a continuous series (see Box 3).

Benefits of annual chain-linking

Replacing fixed base estimates with annual chain-linking would reduce many of the limitations of the fixed base methodology:

- Annual weights would be more up-to-date and therefore more relevant.
- Rebasing revisions will occur to a much lesser extent. After the initial introduction of annual chain-linking, most remaining revisions will occur as a result of an improvement in the quality of input data for the production of indices or weights.
- Annual chain-linking reduces the inaccuracies caused by the assumption of a stable relationship between GVA and turnover. When annual weights are used, the assumption has to be maintained only from one year to the next, but only from the level at which annual chain-linking is implemented.
- For annual chain-linking, every year is automatically a link year, so no subjective choice is required.
- Annual operations are easier to manage and resource than operations which occur on a five-yearly basis. For detailed aggregation at a lower than 4 digit level, five-yearly rebasing will need to continue but the production of annual weights should facilitate this process.

Apparent drawbacks of annual chain-linking

- Except for estimates after the last year which is used as a base year, volume measure estimates will no longer aggregate to totals (as fixed base estimates do from the latest link year onwards).
- Annual chain-linking will require detailed weights for every year, not simply the base year and this will require more work and may increase statistical variation.
- Revisions to Current Price Input-Output Supply and Use Tables will have a greater impact on revisions to constant price GDP.

Box 3

Annual chain-linked indices

The process for calculating annual chain-linked indices for annual data can be divided into a number of separate stages (where "p" indicates the price component, "q" indicates the volume component, "t" is the current time period and "O" is the base time period):

- Calculating year on year volume growth for an industry i (where n such series are aggregated to form GDP):

$$= \frac{p_{i,0} q_{i,t}}{p_{i,0} q_{i,t-1}}$$

- Weighting these year on year growths with GVA weights from the previous year. (The resulting estimates are called "previous years' price" estimates.)

$$= p_{i,t-1} q_{i,t-1} * \frac{p_{i,0} q_{i,t}}{p_{i,0} q_{i,t-1}}$$

$$= p_{i,t-1} q_{i,t}$$

- Aggregating the previous years' prices for all n component series.

$$= \sum_1^{i=n} p_{i,t-1} q_{i,t}$$

- Dividing the resulting aggregated previous years' prices by total weight from the previous year to give base-weighted or Laspeyres indices.

$$= \frac{\sum_1^{i=n} p_{i,t-1} q_{i,t}}{\sum_1^{i=n} p_{i,t-1} q_{i,t-1}} = I_{L,t}$$

- Chain-linking these indices to form a series in which:
 - Value for year "t" divided by value for year "t-1" = $I_{L,t}$
 - Value for year "t+1" divided by value for year "t" = $I_{L,t+1}$
 - Value for year "t+2" divided by value for year "t+1" = $I_{L,t+2}$
 - ... and so on
 and in which the last year for which a weight is available is given the value 100.

The European Dimension

The *European System of Accounts 1995 (ESA95)*⁷ and the *1997 European Union Stability and Growth Pact*⁸ require comparable volume measures for GDP from different EU member states. This has provided the necessary impetus for harmonising member states' methods for producing volume measures. An outline methodology has been agreed between EU partners (see Box 4 and reference⁷ for an explanation of the different index types).

Technical decisions which will affect users

A number of specific technical decisions have been made for implementing annual chain-linking in the UK National Accounts, taking the wide range of users' needs into account (see Box 5).

Consultation suggests that there will be a number of issues for users in changing from fixed base to annual chain-linking.

- **Additivity:** Components in fixed base constant prices (expressed as £million or index numbers), when added up, agree with corresponding aggregate totals, for each year from the latest link year, currently 1994, to the present. This property of the component series is described as "showing additivity". (Prior to the last link year – at present 1994 – components at constant prices do not even now add to corresponding aggregates). With annual chain-linking, much of this additivity for recent years is lost: the extent of the loss depending on the chain-linking method chosen. The UK has decided to use Laspeyres indices for annual

Box 4

Eurostat principles for producing volume measures¹¹

- 1 In the measurement of prices and volumes, a detailed level of aggregation of products shall be used. This level of aggregation, which is referred to as the elementary level of aggregation, shall be at least as detailed as the P60 level of *ESA95*, for output as well as all categories of (intermediate and final) use.
- 2 Volume measures available at the elementary level of aggregation shall be aggregated using the Laspeyres (or Fisher) formula to obtain the volume measures of all national accounts aggregates.
- 3 Volume measures derived at the elementary level of aggregation shall be aggregated using weights derived from the previous year.

chain-linking and to re-reference the chain-linked series to the latest year for which weights are available. This will mean that all estimates from the last base year onwards will still "show additivity". A final decision on which year this will be, has not yet been made. Re-referencing the index number series each year, which is necessary to achieve this additivity, will unavoidably cause some users inconvenience. (Other options, such as Fisher indices, would have resulted in only annual and sub-annual estimates from the last weights year being additive, not estimates before or after that).

- * **Continuity:** For series which are used in econometric models, annual chain-linked estimates will be produced as a priority back to 1970, although for the earlier part of this period annual chain-linking will have to be introduced at a higher level of aggregation.

Box 5

Technical decisions made for introducing Annual Chain-linking into the UK National Accounts

- Annual chain-linking will be carried out using Laspeyres indices and series will be referenced to the last weights year to preserve additivity in the most recent data.
- Annual chain-linking will be applied to historic data back to 1970 at a level at which weights and indices are consistent with current structures. Historic annual chain-linked series will be linked to recent annual chain-linked series.
- Annual chain-linked **quarterly** data will be linked using an overlap on quarter four. Any resultant drift away from the annual growth path will be removed by benchmarking to annual data. The decision was made to use a quarterly overlap method rather than alternatives suggested by Eurostat because it best preserves the quarterly growth path.
- Annual chain-linked **monthly** data will also be linked on quarter 4 and benchmarked to annual data. This will minimise the impact of December to January effects and provides estimates which follow the quarterly growth path.
- The level at which annual chain-linking will be implemented for GDP(O) will meet Eurostat requirements and will be implemented at an even lower level where constant price data is consistently available and modelling has shown that this chain-linking may significantly alter growth estimates.
- The monthly Index of Production will also be annual chain-linked to give consistency between monthly, quarterly and annual published estimates.

* **Consistency between measures:** Two approaches for producing annual chain-linked growth estimates have been identified in the UK⁵. Annual chain-linked estimates of GDP could be calculated independently using the output and expenditure measures and then any differences resolved as they are now. Alternatively, growth measures weighted using the previous years' prices could be aggregated up to the Input-Output level, balanced in Constant Price Input-Output tables each year and then the balanced figures aggregated and chain-linked from one year to the next. In the UK, the development of Constant Price Input-Output tables and annual chain-linked estimates will occur independently to meet the deadlines of 2002 for experimental Constant Price Input-Output tables and 2003 for publishing annual chain-linked GDP. However, in the long-term, a UK objective is to fully integrate the two developments to provide a check on numerical consistency and reliability of the set of measures as a whole.

Anticipated effects of annual chain-linking on the estimates

As described in the section on the limitations of fixed base methodology, out-of-date weights could potentially over- or under-weight volume measures, or have no effect if weights remained stable over time. Economic theorists have suggested that introducing GVA weights from a more recent period will tend to result in lower growth estimates in GDP¹⁵. They hypothesise that this will occur because industries with fast-growing volumes are both the most important part of an economy and are often associated with even faster falling prices⁹. Analysis of the effects of rebasing in 1998 support this, as overall GDP growth was revised slightly downwards for most recent years when the year used for the base weights was updated¹⁰. The results from this investigation into the effects of annual chain-linking should test this hypothesis further.

Methodological specifications for annual chain-linking GDP(O)

Level of Implementing Annual Chain-linking in GDP(O)

EU requirements mean that member states' annual chain-linking must be implemented using at least the 'P60' breakdown, which approximates to the SIC92 (Standard Industrial Classification 1992) two digit industry level.⁷ A comparison was made of the effects on growth of implementing annual chain-linking at broadly 2 digit level against a more detailed broadly 4 digit SIC level using an aggregation structure which was a simplified version of that used in *Blue Book 2000*¹³. In practice, there were over 300 input series at broadly 4 digit level, compared with less than 60 series at broadly 2 digit level.

Annual detailed weights for each of these were constructed by interpolating and extrapolating from 1995 detailed weights. The results showed some significant growth differences with the 4 digit level implementation producing the lowest estimates of growth (see Table 1). For example, the fixed base growth from this simplified structure in 1999 was 2.8 per cent, whereas implementation of annual chain-linking at 2 digit level would have given 2.6 per cent and 2.3 per cent at 4 digit level. The decision was therefore made to introduce annual chain-linking in the UK at the broadly 4 digit level, despite the extra work, because it was felt that an improvement would result in the growth estimates. (For components of the expenditure measure of GDP, annual chain-linking will be introduced at a level of aggregation comparable to the 4 digit level of the output measure, where that is practical.)

Where 4 digit series are compiled from lower level series, lower level aggregation will take place using the fixed base method as in the present system. This will necessitate full rebasing every 5 years, as at present, to update these more detailed weights. Investigations will be carried out to determine the viability of introducing annual chain-linking at a lower level for industries where prices are often volatile.

Where data are supplied from external sources at a higher level of aggregation than 4 digit level (see Table 2), GDP(O) will implement annual chain-linking at this level of input. In the long-term, the aim is for annual chain-linking to be introduced at a lower level, either by the external suppliers themselves or by asking the external supplier to deliver more detailed information (either by SIC or another further disaggregation) to the National Accounts. This will ensure that the effects of annual chain-linking are not biased towards industries for which data are available at a detailed level.

Construction of annual weights for these estimates

At present, a full set of detailed Gross Value Added weights to broadly 4 digit level (lower where necessary) are calculated every five years using Current Price Input-Output GVA totals¹² and other more detailed sources. Annual chain-linking needs detailed weights calculated every year. For *Blue Book 2003*, it is intended that a routine procedure for producing detailed annual weights will be operational. However, for these present estimates of the effects of annual chain-linking on GDP(O), approximate weights have been constructed for the period 1994 to 1999. This has been carried out using the detailed weights now available for 1990 and 1995, then constraining the component totals to published UK Input-Output group industry sub-totals for 1994 and for years following 1995 (see Annex A). An example of the calculations for annual chain-linking (see Box 3), showing how these annual weights are applied, can be seen in Annex B.

Table 1 Modelled growth estimates for the output measures of GDP using three different approaches

	Fixed base	Annual chain-linking introduced at 2 digit level	Annual chain-linking introduced at 4 digit level
1995	2.8	2.9	3.2
1996	3.3	3.3	3.3
1997	3.4	3.3	3.4
1998	3.3	3.3	3.3
1999	2.8	2.6	2.3

The aggregation structure and inputs used to create Table 1 were broadly consistent with *Blue Book 2000*. Annual detailed weights for the annual chain-linking methods were constructed by interpolating and extrapolating from 1995 detailed weights. Growth is published to one decimal place.

Table 2 Data supplied to GDP(O) at a level above 4 digit SIC detail.

External supplier	Components of GDP(O)	SIC Level of delivery
Department of Environment, Food and Rural Affairs (formerly supplied by MAFF).	Section A: Agriculture, hunting and forestry	2 digit level
	Section B: Fishing	2 digit level
Department of Trade and Industry (construction formerly supplied by DETR)	Section E: Electricity, Gas and Water supply	2/3 digit level
	Section F: Construction	2 digit level
Civil Aviation Authority	Division 62 Air Transport in Section I: Transport, storage and communication	2 digit level

Adjustments in the annual chain-linked GDP(O) estimates

In the current fixed base GDP(O) system, additive adjustments for data quality and to achieve alignment between GDP measures are taken on at 2 digit industry level². For comparative purposes, the annual chain-linking system, described here, takes on the same adjustments at 2 digit level. It is not possible to replicate exactly the effects of these adjustments in the fixed base system, but, by taking them on in the annual chain-linked system, it improves comparability. The fixed base system also includes small additive adjustments in some industrial groups to ensure published totals match previously calculated totals for 1994 to 1997. These would be impossible to remove. Although the effect of these adjustments is very small individually, in some cases the combination has affected the comparability of estimates. Therefore, the expected result of zero growth differences for 1996, between fixed base and annual chain-linked estimates (because both use 1995 weights in this year) is not always achieved.

The input data for the annual chain-linked system also includes the effect of multiplicative annual coherence adjustments, shown in *Blue Book 2001* as in previous *Blue Books* to balance the three measures

of GDP. Their inclusion also increase the comparability of the two aggregation methods, fixed base and annual chain-linking.

Annual chain-linked estimates compared with *Blue Book 2001* estimates

In addition to a comparison of the overall GDP(O) estimates, as recently published in *Blue Book 2001*, with the corresponding overall estimates of GDP(O) from the annual chain-linking system, some detailed chain-linked series in Section I (Transport, Storage and Communications industries) were compared with their fixed base counterparts. Section I was chosen because it includes both "high tech" (telecommunications) and "lower tech" industries (transport), in addition to a series, "Air transport", which is supplied to compilers at a high level of aggregation and so cannot be annual chain-linked here.

Annual chain-linking using constructed annual weights shows a small effect on overall GDP with a tendency to depress growth slightly in the latest years (see Figure 2). This suggests that at the level of overall GDP, the introduction of annual chain-linking will not produce

large revisions for years up to and including 2000. For example, the effect is to reduce 2000 growth by 0.3 per cent.

For the production industries (the Index of Production), annual chain-linking (using constructed weights) has a mixed effect on growth (see Figure 3).

For Total Services, annual chain-linking using constructed weights has also had the effect of reducing growth, by 0.5 percentage points in 1999 and 2000 (see Figure 4).

Figure 5 shows the growth estimates for Section I: Transport, Storage and Telecommunications, approximately one eighth of Total Services. In the same way as for total services, annual chain-linking has tended to reduce growth in the latest years of Section I, particularly 1999 (by 0.9 per cent), though less for 2000 (by 0.7 per cent). The three biggest component industries in Section I are “Post and Telecommunications”, “Land transport” and “Transport support” in order of size of their GVA weights (see Table 3). Two of them, Post and Telecommunications and Transport support show a reduction in volume growth from 1999 to 2000 (Figures 6 to 8) and have lower weights in 1998 (used to weight 1999 indices) than in 1995 (the latter is used to weight the indices in the fixed base system). The combined effects of these appear to have counteracted the higher growth estimate in Land Transport and driven the reduction in growth for Section I in 1999.

Figure 3
Annual growth for the Index of Production comparing fixed base and annual chain-linking

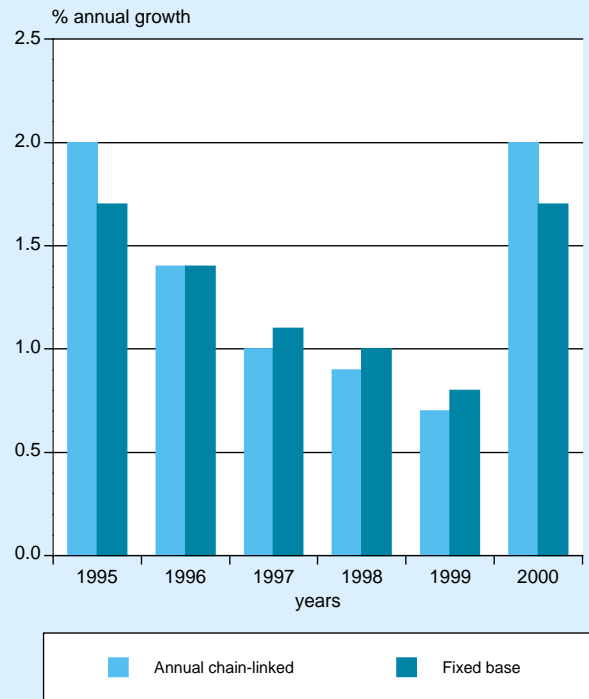


Figure 2
Annual growths for the overall output measure of Gross Domestic Product, comparing fixed base and annual chain-linking

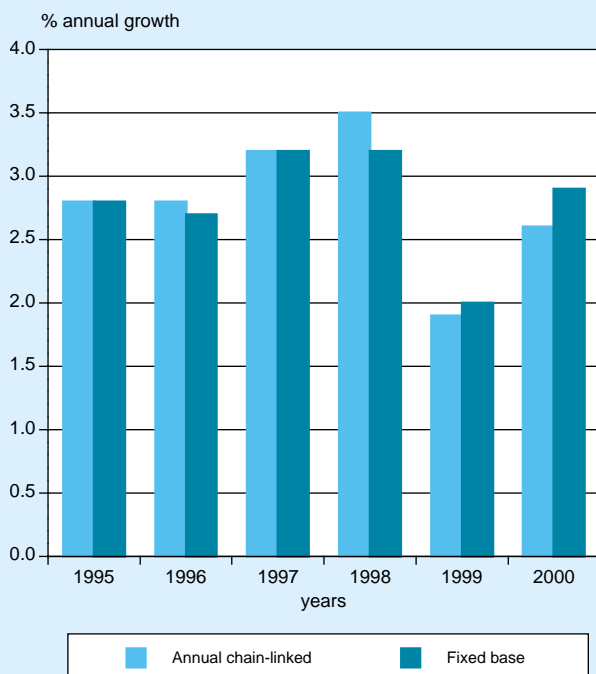


Figure 4
Annual growth for Total Services comparing fixed base and annual chain-linking

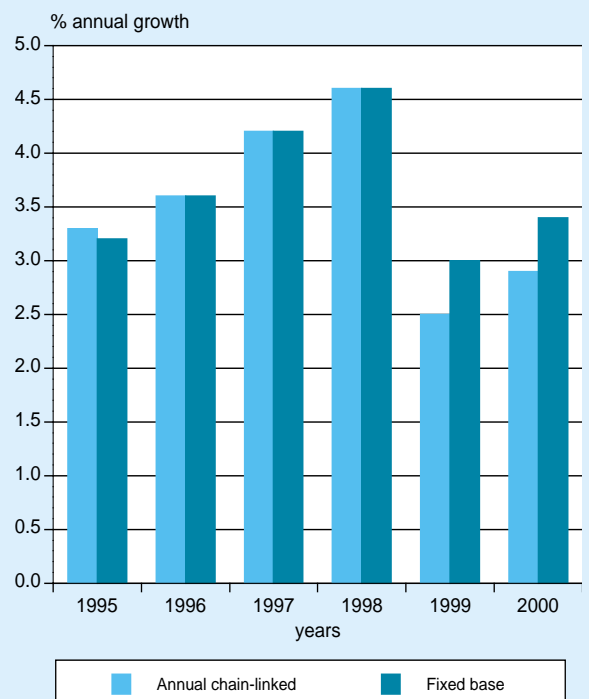


Figure 5

Annual growth for Section I of Services (Transport, Storage and Communication) comparing fixed base and annual chain-linking

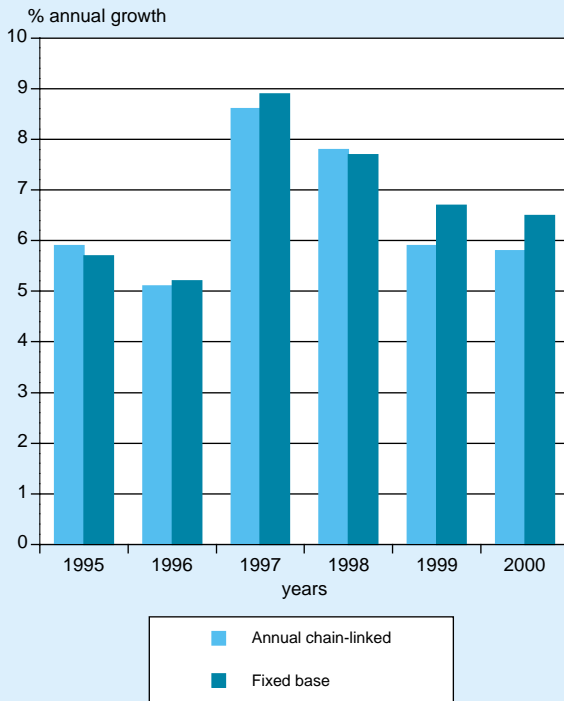


Figure 7

Annual growth for Division 63 (Support and auxiliary transport activities) comparing fixed base and annual chain-linking

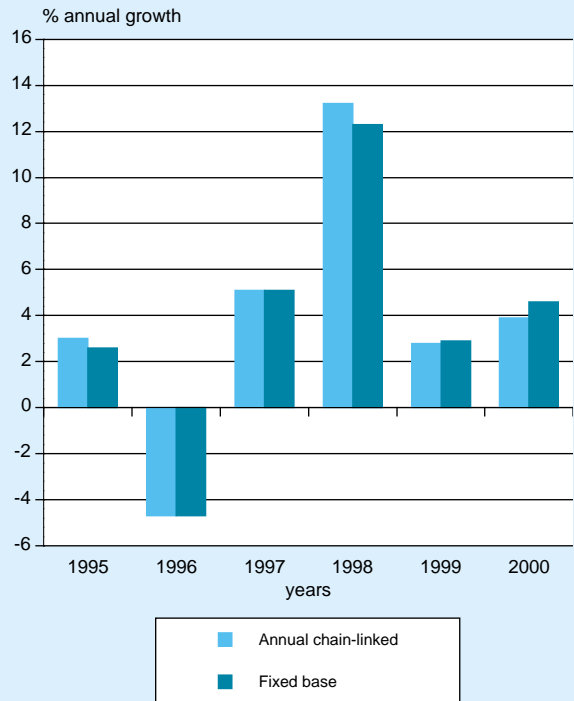


Figure 6

Annual growth for Division 60 (Land transport) comparing fixed base and annual chain-linking

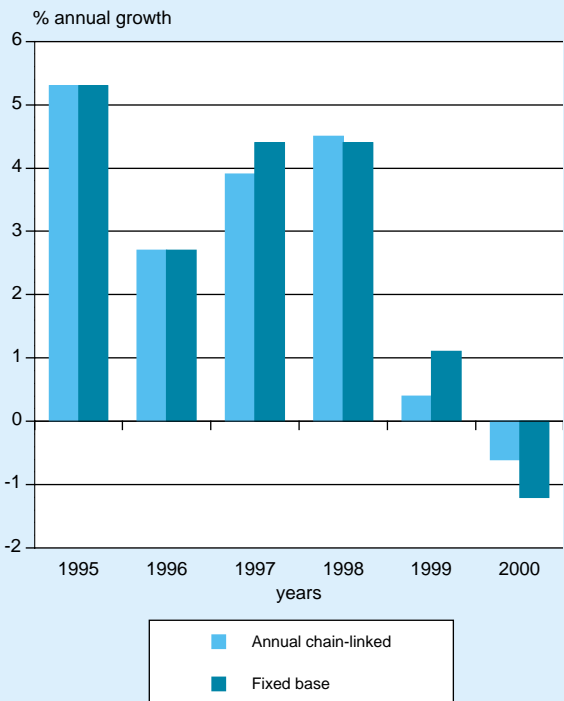


Figure 8

Annual growth for Division 64 (Post and telecommunications) comparing fixed base and annual chain-linking

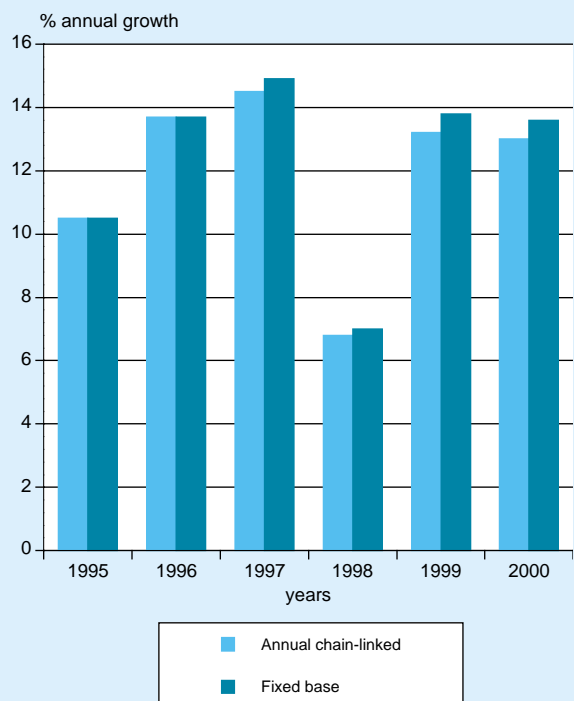


Table 3 Section I (Transport and Telecommunications) volume measure indices (a) and constructed GVA weights (b) at 2 digit and then division level.

a) annual chain-linked indices

	Land Transport	Water Transport	Air Transport	Transport support	Post and Telecommunications	Total Section I
1994	84.9	96.4	68.1	83.3	57.5	72.5
1995	89.4	94.6	74.7	85.8	63.5	76.8
1996	91.8	101.6	79.6	81.7	72.2	80.7
1997	95.4	97.6	88.3	85.9	82.7	87.6
1998	99.6	104.9	95.9	97.3	88.4	94.5
1999	100.0	100.0	100.0	100.0	100.0	100.0
2000	99.4	85.7	105.5	103.9	113.0	105.8

b) GVA annual weights

	Land Transport	Water Transport	Air Transport	Transport support	Post and Telecommunications	Total Section I
1994	25.9	2.5	6.2	17.0	29.9	81.5
1995	25.1	2.6	6.5	17.4	28.6	80.2
1996	23.7	2.7	7.0	18.2	27.2	78.8
1997	23.6	2.6	7.1	18.4	27.7	79.4
1998	23.7	2.4	6.9	19.0	29.4	81.4
1999	23.8	2.1	6.7	19.1	31.0	82.7
2000	-	-	-	-	-	-

Further comparisons for other sections between fixed base and annual chain-linked estimates can be made using Appendices 1 to 3.

Conclusions

The figures in this article show the effects of introducing annual chain-linking on the output measure of GDP. The annual weights used have been constructed by interpolating and extrapolating relative weights from those published for 1990 and 1995 and summing the resulting relative weights to Current Price Input-Output totals. In comparison with fixed base, annual chain-linked shows lower growth estimates in 1999 and 2000 for total service industries (sections G to Q) and overall GDP. This would suggest that industries with fast growing volumes but even faster falling prices have a strong influence on estimates of growth in the UK economy^{9,15}. As described earlier, the reduction in growth is driven by likely reductions in weight of "high tech" and other fast-growing industries, as their volume growth fails to compensate for price falls

The results are consistent with the downward revision of rebasing in 1998. It is likely that estimates for 2001 and 2002 may show an even more pronounced reduction in growth as the 1995 weights will be even further out-of-date for these years. It is also likely that the detailed annual weights in *Blue Book 2003* will not differ too significantly from those used here, although the mathematical construction of these weights will have tended to artificially smooth changes over a period of years. Most of the constructed weights are simply the result of a mathematical process without an attempt to make use of information on price and volume changes which will be used to produce annual weights for *Blue Book 2003*.

The development work necessary to introduce annual chain-linked estimates continues, with work well under way for the components of the expenditure measure of GDP. We expect to see a similar reduction of growth on the expenditure side. Investigations are also being carried out to determine appropriate methods for reconstruction of longer runs of annual chain-linked estimates. Future *Economic Trends* articles will share development progress and results as they are produced.

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Annex A

Constructing detailed weights for 1994 to 1999

Detailed weights at a broadly 4 digit level in Standard Industrial Classification, derived as described in Box 1, exist for 1990 and 1995. For years between 1990 and 1995 and after 1995, no detailed weights currently exist. Balanced GVA totals at 123 level have been calculated for these years and can be found in Current Price Input-Output tables.

For the purpose of producing annual chain-linked volume measures, detailed weights were needed for the time period 1994 to 1999. Weights were constructed for 1994, 1996, 1997, 1998 and 1999 using the following method:

The input data were:

- 1990 detailed weights published in the *Government Statistical Service Methodology Guide* No. 5¹²,
- 1995 detailed weights used to aggregate *Blue Book* 2001 volume measures
- and GVA totals from Current Price Input-Output tables from 1994, 1996, 1997, 1998 and 1999.

The following procedure was used:

- The detailed weights in parts per thousand of GDP(O) were interpolated between 1990 and 1995 and extrapolated from 1995 to 1999 using a multiplicative function of the ratio of the weight in 1995 to the weight in 1990.
- The interpolated and extrapolated weights were then constrained to the Input-Output 123 level totals which had been converted into parts per thousand for 1994, 1996, 1997, 1998 and 1999¹.
- Where detailed weights existed for 1995 but not 1990, the compiler was asked to use further information to construct a 1990 weight for all the series contributing to the same Input-Output total.

Notes:

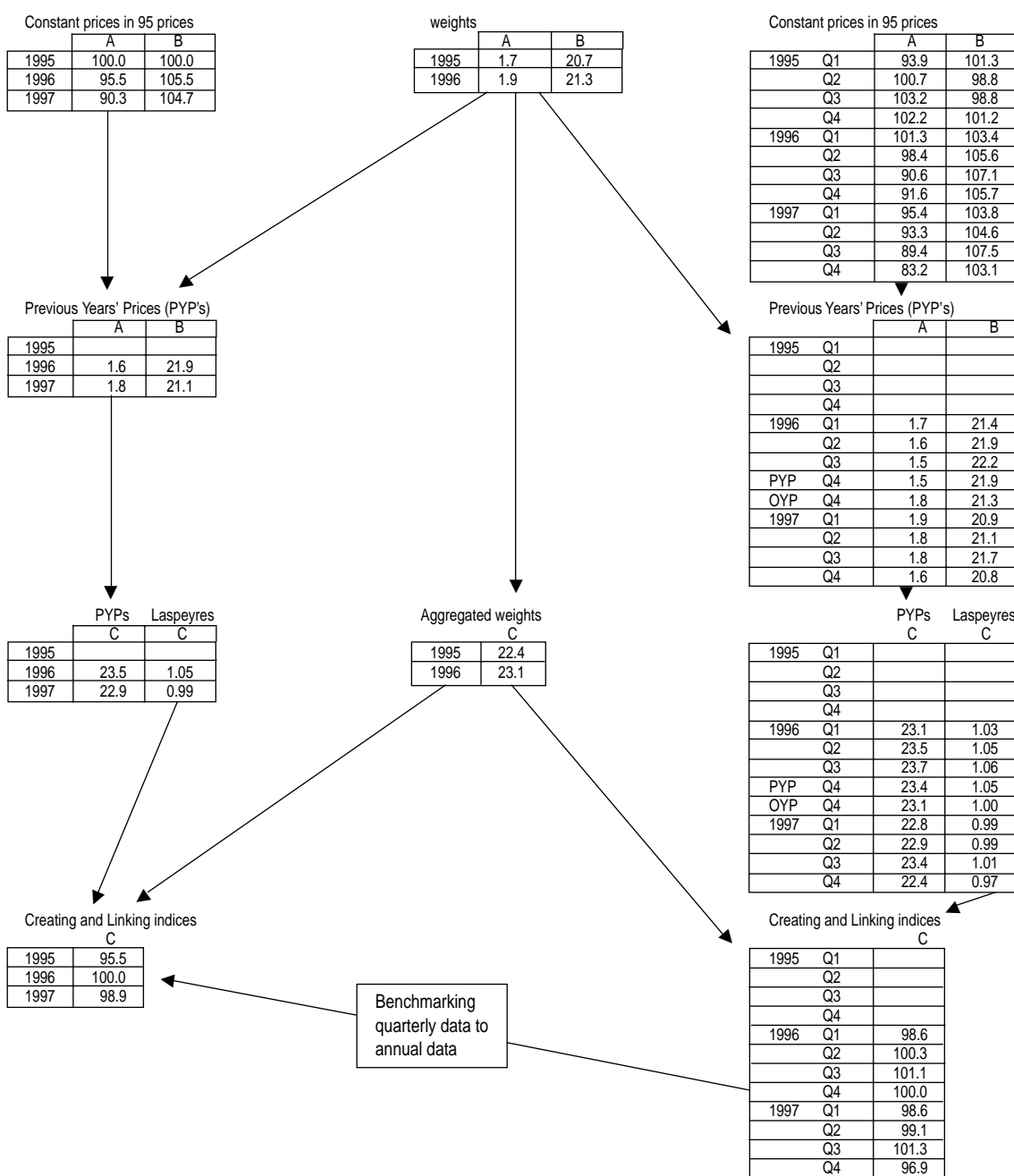
¹ In most cases, detailed weights add directly to Input-Output totals, although for Public Administration, Education and Health, adjustments are made. Teachers' pay is moved from the Input-Output total for Education to Public Administration and NHS administration is moved from Public Administration to Health & Social Work. In the construction of interpolated and extrapolated weights, the adjustment was made using the same proportion of adjustment to total as in 1995 and applied to Input-Output totals before constraining was carried out.

Annex B

Annual chain-linking for annual and quarterly data

This flowchart shows how annual and quarterly data are aggregated using the annual chain-linking method for two hypothetical industries A and B which are aggregated to industry group C. In this example, 1996 is taken to be the "last balanced year" from which weights are available and so this year is referenced to 100. Note that the annual averages of the quarterly estimates are not identical to the annual estimates, showing the need for benchmarking.

- Previous Years' prices are created by multiplying the change in constant prices from one year to the next by the weight in the first year of the pair.
- Previous Years' prices are converted to Laspeyres indices before chain-linking by dividing by total weight in the previous year.
- Annual Laspeyres indices are chain-linked by setting the annual figure for 1996 (the last balanced year) to 100, and using the growth implied in the Laspeyres indices to create figures for 1995 and 1997.
- Quarterly Laspeyres indices are chain-linked by using the ratio of quarter 4 for 1996 in "own years' prices" (OYPs) to quarter 4 in PYP to provide a link factor.



Appendices

Appendix 1: *Blue Book* Table 2.4 as published in *Blue Book* 2001.

Appendix 2: *Blue Book* Table 2.4 with annual chain-linking

Appendix 3: Growth differences – annual chain-linked indices minus
fixed base indices

Appendix 4: GVA annual weights

Appendix 1

UK industrial analyses

2.4 Gross value added at 1995 basic prices: by industry^{1,2,3}

Index numbers

Indices 1995=100

		Weight per 1000 ¹										
		1995	1992	1993	1994	1995	1996	1997	1998	1999	2000	
A,B	Agriculture, hunting, forestry and fishing	18.4	GDQA	111.5	102.5	101.2	100.0	99.1	98.2	99.9	102.2	99.9
C,D,E Production												
C	Mining and quarrying											
CA	Mining and quarrying of energy producing materials											
C10	Mining of coal	1.9	CKZP	181.8	142.3	94.6	100.0	95.5	90.3	76.5	69.1	59.3
C11	Extraction of mineral oil and natural gas	21.4	CKZO	68.4	77.5	96.1	100.0	105.6	104.7	107.5	112.2	110.7
CB	Other mining and quarrying	2.3	CKZQ	103.4	105.6	105.3	100.0	88.7	87.3	97.0	103.6	111.0
C	Total mining and quarrying	25.6	CKYX	78.9	84.2	96.8	100.0	103.3	102.1	104.3	108.2	106.9
D	Manufacturing											
DA	Food; beverages and tobacco	28.5	CKZA	98.9	99.2	101.7	100.0	100.9	103.2	101.5	100.8	99.6
DB	Textiles and textile products	10.7	CKZB	101.9	101.3	103.6	100.0	98.2	95.9	89.0	81.9	78.2
DC	Leather and leather products	1.5	CKZC	95.8	99.1	98.6	100.0	98.6	103.5	89.5	86.6	79.1
DD	Wood and wood products	3.0	CKZD	97.8	100.0	107.8	100.0	98.1	95.5	94.6	89.7	91.6
DE	Pulp, paper and paper products; publishing and printing	27.5	CKZE	93.0	96.0	98.5	100.0	98.0	98.2	98.9	99.1	99.0
DF	Coke, petroleum products and nuclear fuel	4.6	CKZF	88.6	89.0	89.8	100.0	91.8	93.8	88.3	79.4	82.8
DG	Chemicals, chemical products and man-made fibres	23.9	CKZG	88.5	90.4	95.1	100.0	100.6	102.4	104.0	107.4	111.8
DH	Rubber and plastic products	10.6	CKZH	85.1	88.8	97.9	100.0	98.8	98.5	101.6	100.9	100.2
DI	Other non-metallic mineral products	8.1	CKZI	94.7	99.1	102.7	100.0	96.6	99.3	96.9	95.7	95.8
DJ	Basic metals and fabricated metal products	25.2	CKZJ	96.0	95.0	97.3	100.0	99.9	101.1	99.2	95.3	95.5
DK	Machinery and equipment not elsewhere classified	19.2	CKZK	94.7	94.6	99.8	100.0	98.0	95.7	95.8	90.0	89.8
DL	Electrical and optical equipment	27.8	CKZL	79.0	83.4	93.5	100.0	104.9	108.1	114.8	126.0	144.4
DM	Transport equipment	20.4	CKZM	99.9	98.1	100.8	100.0	107.7	112.1	118.2	120.1	115.2
DN	Manufacturing not elsewhere classified	7.6	CKZN	97.2	98.6	101.7	100.0	102.0	104.0	105.3	106.6	104.5
D	Total manufacturing	218.5	CKYY	92.8	94.1	98.5	100.0	100.7	102.0	102.8	103.1	105.1
E	Electricity, gas and water supply	24.4	CKYZ	92.9	96.8	97.7	100.0	105.1	105.7	107.5	109.4	113.1
C,D,E	Total production	268.4	CKYW	91.3	93.3	98.3	100.0	101.3	102.4	103.4	104.2	106.0
F	Construction	51.6	GDQB	97.5	96.3	100.0	100.0	102.7	105.7	107.0	107.8	109.7
G-Q Service industries												
G	Wholesale and retail trade (including motor trade); repair of motor vehicles, personal and household goods	116.6	GDQC	87.7	92.8	97.8	100.0	104.3	107.3	110.8	113.9	117.4
H	Hotels and restaurants	28.5	GDQD	96.0	98.1	100.8	100.0	102.9	103.5	104.5	104.6	101.7
I	Transport, storage and communication											
	Transport and storage	51.6	GDQF	88.1	89.9	96.9	100.0	101.1	106.6	114.5	116.7	118.7
	Communication	28.6	GDQG	79.4	83.5	90.5	100.0	112.7	128.9	139.4	158.8	179.4
I	Total	80.2	GDQH	84.9	87.6	94.6	100.0	105.2	114.6	123.4	131.7	140.3
J	Financial intermediation	65.8	GDQI	93.4	95.5	96.5	100.0	103.7	108.5	113.8	115.3	119.8
-P.119	Adjustment for financial services	-39.4	GDQJ	87.7	88.4	92.5	100.0	106.8	114.1	122.9	125.9	132.1
K	Real estate, renting and business activities											
	Letting of dwellings, including imputed rent of owner occupiers	70.5	GDQL	94.9	96.1	97.4	100.0	101.2	103.2	105.8	107.6	107.9
	Other real estate, renting and business activities	115.6	GDQK	82.0	84.1	92.8	100.0	107.4	118.7	131.6	138.3	147.5
K	Total	186.0	GDQM	86.8	88.9	94.5	100.0	105.1	112.8	121.8	126.7	132.5
L	Public administration and defence	61.0	GDQO	104.6	102.5	100.9	100.0	99.2	98.4	97.4	96.8	98.0
M	Education	55.5	GDQP	95.0	95.0	98.7	100.0	101.3	102.4	102.9	103.7	104.1
N	Health and social work	64.7	GDQQ	89.4	93.5	95.9	100.0	103.2	106.5	110.2	113.7	116.7
O,P,Q	Other social and personal services, private households with employees and extra-territorial organisations	42.6	GDQR	83.5	90.5	96.1	100.0	105.4	107.5	112.8	115.0	119.3
G-Q	Total service industries	661.6	GDQS	89.8	92.5	96.9	100.0	103.6	108.0	112.9	116.3	120.3
B.1g	All industries	1 000.0	CGCE	90.6	92.8	97.3	100.0	102.7	106.0	109.4	111.6	114.8

1 The weights are in proportion to total gross value added in 1995. The GVA for sections L, M, and N in this table follows the SIC(92) and differs from that shown in Table 2.3, which is based on Input-Output groups. Central government expenditure on teachers' pay is included in Education in Table 2.4 but in PAD in Table 2.3. The administration costs of the NHS are included in PAD in Table 2.4 but are included in Health and social work in Table 2.3.

2 The output analysis of gross value added is estimated in terms of change and expressed in index number form. It is therefore inappropriate to show as a statistical adjustment any divergence of an output measure of GDP derived from it from other measures of GDP. Such an adjustment does, however, exist implicitly.

3 See footnote 2 to Table 2.3.

Appendix 2

2.4CHNI Annual Chain-linked Gross Value Added indices for Economic Trends

Article: by industry¹

Index numbers			Indices 1999=100						
			1994	1995	1996	1997	1998	1999	2000
Agriculture, hunting, forestry and fishing	FUDY	A,B	98.5	97.4	96.5	95.6	97.8	100.0	97.5
Production		C,D,E							
Mining and quarrying		C							
Mining and quarrying of energy producing materials		CA							
Mining of coal	FUBI	C10	136.8	144.6	138.1	130.6	110.7	100.0	85.8
Extraction of mineral oil and natural gas	FUBJ	C11	85.7	89.1	94.1	93.3	95.8	100.0	98.7
Other mining and quarrying	CKZQ	CB	110.4	102.3	90.7	86.6	93.7	100.0	115.7
Total mining and quarrying	BCXH	C	89.6	92.4	95.5	94.2	96.3	100.0	99.9
Manufacturing		D							
Food; beverages and tobacco	CKZA	DA	99.8	98.7	99.6	102.1	100.1	100.0	99.7
Textiles and textile products	CKZB	DB	127.2	122.9	120.7	117.8	109.2	100.0	96.3
Leather and leather products	CKZC	DC	115.0	116.7	115.0	120.6	104.1	100.0	94.0
Wood and wood products	CKZD	DD	119.4	110.9	108.8	106.3	105.4	100.0	102.9
Pulp, paper and paper products; publishing & printing	CKZE	DE	99.1	100.8	98.8	98.7	99.7	100.0	100.2
Coke, petroleum products and nuclear fuel	CKZF	DF	112.7	127.3	116.8	119.9	112.5	100.0	105.8
Chemicals, chemical products and man-made fibres	CKZG	DG	87.9	92.6	93.1	94.9	96.4	100.0	105.4
Rubber and plastic products	CKZH	DH	96.3	98.7	97.5	97.4	100.4	100.0	99.3
Other non-metallic mineral products	CKZI	DI	107.4	105.0	101.5	104.2	101.1	100.0	100.9
Basic metals and fabricated metal products	CKZJ	DJ	101.0	104.1	104.0	105.4	103.8	100.0	100.9
Machinery and equipment not elsewhere classified	CKZK	DK	110.4	111.3	109.0	106.6	106.7	100.0	99.7
Electrical and optical equipment	CKZL	DL	73.8	79.5	83.4	85.9	90.6	100.0	114.4
Transport equipment	CKZM	DM	84.4	83.4	89.8	93.3	98.1	100.0	96.0
Manufacturing not elsewhere classified	CKZN	DN	94.3	93.0	94.9	96.8	98.2	100.0	99.6
Total manufacturing	BCXI	D	95.2	97.0	97.7	99.0	99.7	100.0	102.1
Electricity, gas and water supply	BCXJ	E	89.4	91.7	96.4	96.9	98.5	100.0	103.1
Total production	FUDZ	C,D,E	94.2	96.1	97.4	98.4	99.3	100.0	102.0
Construction	ZSEC	F	92.8	92.8	95.3	98.0	99.3	100.0	101.9
Service industries		G-Q							
Wholesale and retail trade (including motor trade); repair of motor vehicles, personal & household goods	ZUNY	G	85.6	87.6	91.5	94.3	97.6	100.0	102.2
Hotels and restaurants	ZSGI	H	97.9	97.2	99.9	99.8	100.0	100.0	96.7
Transport, storage and communication		I							
Transport and storage	FUYA		82.8	85.6	86.3	91.3	98.4	100.0	101.9
Communication	FTLQ		57.7	63.7	71.8	81.9	88.3	100.0	112.2
Total	FVHV	I	72.5	76.8	80.7	87.6	94.5	100.0	105.8
Financial intermediation	FVHS	J	85.4	88.5	91.8	95.6	98.5	100.0	102.6
Adjustment for financial services	ZOXO	-P.119	74.9	81.3	86.9	92.3	97.5	100.0	104.2
Real estate, renting and business activities		K							
Letting of dwellings, including imputed rent of owner occupiers	FUDS		90.5	92.9	94.1	95.9	98.3	100.0	100.3
Other real estate, renting and business activities	FVHT		68.4	73.8	79.1	87.3	97.0	100.0	106.3
Total	FVHA	K	75.6	80.0	84.0	90.1	97.4	100.0	104.3
Public administration and defence	FTVT	L	103.8	102.9	102.2	101.7	100.7	100.0	101.4
Education	FVHC	M	95.2	96.4	97.7	98.8	99.2	100.0	100.4
Health and social work	FVHP	N	84.4	88.0	90.7	93.7	96.9	100.0	102.6
Other social and personal services, private households with employees and extra-territorial organisations	FUEB	O,P,Q	81.9	85.3	90.2	92.4	96.9	100.0	104.0
Total service industries	FUEA	G-Q	83.7	86.5	89.6	93.3	97.6	100.0	102.9
All industries	FTTC	B.1g	87.0	89.4	91.9	94.8	98.1	100.0	102.6

¹ The output analysis of gross value added is estimated in terms of change and expressed in index number form. It is therefore inappropriate to show as a statistical adjustment any divergence of an output measure of GDP derived from it from other measures of GDP. Such an adjustment does, however, exist implicitly.

Appendix 3

2.4GWDIF Yr-on-yr growth rates. Chain-linked minus Nonchain-linked GVA for Economic Trends Article: by industry^{1,2}

Percentage difference

		1995	1996	1997	1998	1999	2000
Agriculture, hunting, forestry and fishing	A,B	-	-	-	0.6	-0.1	-0.2
Production	C,D,E						
Mining and quarrying	C						
Mining and quarrying of energy producing materials	CA						
Mining of coal	C10	-	-	-	-	-	-
Extraction of mineral oil and natural gas	C11	-0.1	-	-	-	-	-
Other mining and quarrying	CB	-2.3	-	-3.0	-2.9	-	8.5
Total mining and quarrying	C	-0.1	-	-0.2	-	0.1	1.1
Manufacturing	D						
Food; beverages and tobacco	DA	0.5	-	0.2	-0.3	0.6	0.9
Textiles and textile products	DB	0.1	-	-0.1	-	-0.5	0.8
Leather and leather products	DC	-	-	-0.1	-0.2	-0.7	2.7
Wood and wood products	DD	0.1	-	0.4	0.1	-	0.8
Pulp, paper and paper products; publishing & printing	DE	0.1	-	-0.2	0.2	0.1	0.3
Coke, petroleum products and nuclear fuel	DF	1.6	-	0.4	-0.3	-1.0	1.6
Chemicals, chemical products and man-made fibres	DG	0.2	-	0.2	-	0.4	1.4
Rubber and plastic products	DH	0.4	-	0.2	-0.1	0.3	-
Other non-metallic mineral products	DI	0.4	-	-0.1	-0.6	0.1	0.8
Basic metals and fabricated metal products	DJ	0.3	-	0.1	0.4	0.3	0.7
Machinery and equipment not elsewhere classified	DK	0.6	-	0.1	-	-0.2	-0.1
Electrical and optical equipment	DL	0.8	-	-	-0.7	0.6	-0.2
Transport equipment	DM	-0.5	-	-0.2	-0.4	0.4	-
Manufacturing not elsewhere classified	DN	0.3	-	-	0.2	0.6	1.6
Total manufacturing	D	0.4	-	0.1	-0.1	-	0.1
Electricity, gas and water supply	E	0.2	-	-0.1	-0.1	-0.2	-0.2
Total production	C,D,E	0.4	-	-0.1	-0.1	-0.1	0.2
Construction	F	-	-	-0.1	-	-	0.2
Service industries	G-Q						
Wholesale and retail trade (including motor trade); repair of motor vehicles, personal & household goods	G	-	0.1	0.2	0.3	-0.3	-0.9
Hotels and restaurants	H	-	-0.1	-0.7	-0.7	-0.1	-0.6
Transport, storage and communication	I						
Transport and storage		0.1	-0.2	0.3	0.4	-0.3	0.2
Communication		-	-	-0.4	-0.3	-0.6	-0.7
Total	I	0.2	-0.1	-0.4	0.1	-0.9	-0.7
Financial intermediation	J	-	-	-0.5	-1.8	0.2	-1.3
Adjustment for financial services	-P.119	0.4	-	-0.5	-2.1	0.1	-0.7
Real estate, renting and business activities	K						
Letting of dwellings, including imputed rent of owner occupiers		-	0.1	-0.1	-	-	-
Other real estate, renting and business activities		0.1	-0.1	-0.2	0.2	-2.0	-0.4
Total	K	-	-0.1	-0.1	0.1	-1.4	-0.3
Public administration and defence	L	-	0.1	0.2	-	-	0.2
Education	M	-	-	-	-	-	-
Health and social work	N	-	-0.1	-	-	-	-
Other social and personal services, private households with employees and extra-territorial organisations	O,P,Q						
		-	0.4	0.5	-	1.2	0.3
Total service industries	G-Q	0.1	-	-	-	-0.5	-0.5
All industries	B.1g	-	0.1	-0.1	0.3	-0.1	-0.3

1 As 1996 growth rates using fixed base methodology and annual chain-linking methodology both use 1995 weights, the differences for 1996 should all read zero (represented by a dash). The small discrepancies displayed are a result of: a) additive adjustments made to data (which although taken on in the annual chain-linked system, will not have an identical effect to those in the fixed base system); b) the inclusion of adjustments in the fixed base system which ensure published totals match previously calculated totals for 1994 to 1997; c) the effects of rounding in the fixed base system.

2 Series which show zero differences in all years are those which have not been annually chain-linked at the published level because input data is supplied at this level.

Appendix 4

2.4CHNW Annual GVA weights for Economic Trends Article: by industry¹

		Weight per 1000 ¹ 1994	1995	1996	1997	1998	1999
Agriculture, hunting, forestry and fishing	A,B	17.4	18.4	17.3	14.1	12.6	11.9
Production	C,D,E						
Mining and quarrying	C						
Mining and quarrying of energy producing materials	CA						
Mining of coal	C10	1.7	1.9	1.5	1.4	1.1	0.8
Extraction of mineral oil and natural gas	C11	20.5	21.4	25.2	21.4	17.4	18.7
Other mining and quarrying	CB	2.0	2.3	2.4	2.4	2.2	2.1
Total mining and quarrying	C	24.3	25.6	29.1	25.2	20.6	21.5
Manufacturing	D						
Food; beverages and tobacco	DA	30.0	28.5	29.4	28.3	26.4	25.7
Textiles and textile products	DB	10.6	10.7	10.8	10.7	9.1	8.1
Leather and leather products	DC	1.7	1.5	1.3	1.2	1.1	1.0
Wood and wood products	DD	2.9	3.0	3.0	3.1	3.0	2.7
Pulp, paper and paper products; publishing & printing	DE	26.3	27.5	26.4	25.2	24.7	25.2
Coke, petroleum products and nuclear fuel	DF	4.4	4.6	3.7	3.3	3.4	3.5
Chemicals, chemical products and man-made fibres	DG	22.9	23.9	23.3	21.5	19.9	18.8
Rubber and plastic products	DH	10.4	10.6	10.7	11.1	10.8	9.8
Other non-metallic mineral products	DI	7.7	8.1	7.7	7.2	6.6	6.1
Basic metals and fabricated metal products	DJ	23.2	25.2	24.0	23.6	23.1	21.2
Machinery and equipment not elsewhere classified	DK	18.2	19.2	18.4	18.7	17.9	15.9
Electrical and optical equipment	DL	27.2	27.8	27.5	27.9	26.5	26.2
Transport equipment	DM	21.9	20.4	21.2	21.7	21.1	20.3
Manufacturing not elsewhere classified	DN	7.3	7.6	8.0	8.4	8.2	8.0
Total manufacturing	D	214.8	218.5	215.3	212.1	201.7	192.4
Electricity, gas and water supply	E	26.2	24.4	23.7	22.4	21.1	20.2
Total production	C,D,E	265.3	268.4	268.1	259.6	243.5	234.2
Construction	F	51.3	51.6	50.9	51.2	50.6	51.8
Service industries	G-Q						
Wholesale and retail trade (including motor trade); repair of motor vehicles, personal & household goods	G	117.7	116.6	116.8	119.9	122.8	125.6
Hotels and restaurants	H	27.7	28.5	29.8	31.1	32.0	32.2
Transport, storage and communication	I						
Transport and storage		51.6	51.6	51.6	51.7	51.9	51.8
Communication		29.9	28.6	27.2	27.7	29.4	31.0
Total	I	81.5	80.2	78.8	79.4	81.4	82.7
Financial intermediation	J	69.6	65.8	60.2	56.3	59.5	53.7
Adjustment for financial services	-P.119	-38.0	-39.4	-33.2	-31.1	-36.8	-38.8
Real estate, renting and business activities	K						
Letting of dwellings, including imputed rent of owner occupiers		69.6	70.5	68.7	69.7	72.8	73.8
Other real estate, renting and business activities		112.0	115.6	120.6	129.0	140.9	149.9
Total	K	181.6	186.0	189.3	198.7	213.8	223.7
Public administration and defence	L	64.3	61.0	57.8	54.5	51.8	49.7
Education	M	56.0	55.5	55.7	55.7	56.1	58.0
Health and social work	N	63.5	64.7	64.2	63.7	63.8	65.3
Other social and personal services, private households with employees and extra-territorial organisations	O,P,Q	42.1	42.6	44.2	46.9	48.9	50.0
Total service industries	G-Q	665.9	661.6	663.7	675.1	693.2	702.1
All industries	B.1g	1 000.0	1 000.0	1 000.0	1 000.0	1 000.0	1 000.0

¹ The weights are in proportion to total gross value added in each year. The GVA for section L, M and N in this table follows the SIC(92) and differs from that shown in the UK Input-Output Supply and Use Tables for each year. Central government expenditure on teachers' pay is included in Education in PAD in Input-Output Tables. The administration costs of the NHS are included in PAD in Table 2.4 but are included in Health and Social Work in Input-Output tables.

The gross domestic product (GDP) growth rate measures how fast the economy is growing. It does this by comparing a quarter of the country's gross domestic product to the previous quarter. GDP measures the economic output of a nation. The GDP growth rate is driven by the four components of GDP. The primary driver of GDP growth is personal consumption, which includes the critical sector of retail sales. Real GDP takes out the effect of inflation. Even though the growth rate is reported quarterly, the BEA annualizes it. That's so it can compare growth to the previous year. In other words, in any given quarter, the BEA reports what GDP is for the year. How Is Average Annual Growth Calculated? Accessed April 7, 2020. Bureau of Economic Analysis.