

Revisions to quarterly GDP growth and its production (output), expenditure and income components

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This article presents the results of the latest revisions analysis of Gross Domestic Product (GDP), updating and developing the previous article, Robinson (2005), published in December 2005. It analyses revisions to the estimates of quarterly GDP at different stages of the production process, and assesses the reliability of initial estimates over two different time periods.

The article also presents analysis of revisions to quarterly growth rates for the main components of the expenditure, production and income measures of GDP and the impact of these revisions on headline GDP. More detailed analysis of the components can be found in the appendices to this article available at www.statistics.gov.uk/ci/article.asp?id=1689

Introduction

The quality of GDP estimates can be assessed using a variety of measures. Of these, revisions analysis measures the reliability of an early estimate in predicting the value of a later estimate. Revisions analysis does not measure accuracy, which relates to how close the estimate is to the underlying true value. It is possible that a reliable estimate (in that it is revised only very slightly over time) could be very inaccurate (in its closeness to the underlying 'true' value), and *vice versa*.

Reliability (measured through revisions analysis) is only one aspect of quality and should be considered as part of a wider range of indicators of quality that address issues such as timeliness and coherence. Quality reports provide information on different elements of quality (including reliability) and include both static and dynamic quality information specific to a release. More information on quality reports is available at www.statistics.gov.uk/about_ns/economicstatistics_qualityreports.asp.

This article provides a summary of the analysis of revisions to quarterly GDP growth rates, and also to the components of the production (or output), expenditure and income measures of GDP. In addition, it assesses the revisions to initial estimates over two different time periods to determine if reliability has improved or worsened. The impact of revisions to the components of production (or output), expenditure and income on headline GDP is also addressed.

For most of the analysis, seasonally adjusted data and chained volume measures (or constant prices) are used. For the income components of GDP, the analysis uses seasonally adjusted data but at current prices, not chained volume measures, due to the nature of how the data are collected and the difficulty of deflating the components. The detailed analyses of revisions to the components are available in the appendices to this article which are available at www.statistics.gov.uk/ci/article.asp?id=1689

Key findings

- The initial estimate of quarterly GDP growth is, on average, 0.18 percentage points below the latest estimate. This is statistically significant.
- Within the compilation process for GDP, the largest mean revision is seen post-Blue Book 2 (BB2). The M1 estimate of quarterly GDP is the best indicator of the M3 estimate. The results also indicate the M3 estimate is a good indicator of the Blue Book 1 (BB1) estimate, with the least reliable stage being BB2 to latest.
- The reliability assessment indicates a slight overall improvement in the second time period for GDP with improved reliability at most stages.
- For output components, the largest mean revisions are in agriculture and total production at 0.47 and 0.20 percentage points respectively, with the first estimate for agriculture the least reliable and total services the most reliable.
- Total services has the lowest mean absolute revision but the largest impact on gross value added (GVA) due to its proportion. Within total services, transport, storage and communication has the largest mean revision at 0.43 percentage points with an even larger mean absolute revision. Government and other services have the most reliable first estimate, while transport, storage and communication has the least reliable.
- Within expenditure, gross fixed capital formation (GFCF) has the largest mean revision at 1.30 percentage points. Mean revisions to exports and imports are relatively large at 1.43 and 1.23 percentage points respectively. Of all the expenditure components, the household final consumption expenditure (HHFCE) first estimate is the most reliable.
- Of the income components, financial corporations has the largest mean revision at 6.04 percentage points and has the biggest impact on headline GDP. Compensation of employees has the most reliable first estimate.

Approaches to measuring GDP

GDP can be measured using three theoretical approaches:

- production (or output)
- expenditure, and
- income

The production (or output) approach measures the sum of the value added created through the production of goods and services within the economy; the expenditure approach measures the total expenditure on all finished goods and services produced within the economy; and the income approach measures the total income generated by the production of goods and services in the economy.

The components of each approach to measuring GDP are estimated through sample surveys and administrative sources. In the short run, forecasts and models are used to estimate

growth for the later months of the quarter, for which data have not yet been collected. In the long run, these forecasts are replaced with the actual data when they become available. A single estimate is then derived through a balancing process and published as the official estimate of GDP. For more details on the balancing process see Box 2 in Robinson (2005).¹

GDP framework

The production of quarterly GDP in the UK follows a number of stages. The main stages of the production process are outlined below. Analysis of the availability of actual data at each stage has been covered in previous *Economic Trends* articles, Skipper (2005) and Mahajan (2004).

- Month 1 (M1) – the first estimate of GDP quarterly growth is published around 25 days after the end of the quarter in the GDP Preliminary Estimate First Release. This preliminary estimate is based on 44 per cent ‘actual’ data and is driven by the output approach to GDP.
- Month 2 (M2) – the second estimate is published around 55 days after the end of the quarter in the UK Output, Income and Expenditure First Release. This is based on 67 per cent of actual output data, as well as early estimates of the expenditure (60 per cent actual data) and income estimates.
- Month 3 (M3) – the third estimate is published around 85 days after the end of the quarter in the Quarterly National Accounts First Release. This is based on 80 per cent of actual data encompassing fuller survey data for components of output, expenditure and income. This release includes updated data for the estimate in the current quarter as well as updated estimates for earlier quarters.
- Blue Books (BB) – annual GDP estimates are published in the *Blue Book*, usually in June. The quarterly data are updated again during the production of the first (BB1) and second (BB2) estimates of annual GDP, as data from new and more comprehensive annual data sources become available. The second time an annual estimate is published in the Blue Book, Input-Output Supply and Use Tables are produced and used to reconcile the three measures of GDP for the first time. The Input-Output Supply and Use balancing process is re-run in subsequent Blue Books using further benchmark data and any methodological improvements that are being implemented.²

In this article, revisions to quarterly GDP growth rates are analysed over the periods between:

- M1 and M3
- M3 and BB1 (the first time an annual estimate is published)
- BB1 and BB2 (the second time an annual estimate is published)
- BB2 and the latest estimate (post-BB2)

For the analysis of quarterly GDP growth rates, the time series used runs from the first quarter of 1994 to the final quarter

of 2003. Taking the analysis only as far as the final quarter of 2003 ensures that all the estimates have had at least three years to mature and have all been through two Blue Books.

Data in this article are comparable with the data used in the revisions analysis in GDP First Releases, but the analysis is carried out over different time periods and so the summary statistics will not be the same. For consistency, revisions analyses in all Office for National Statistics (ONS) First Releases conform to standard time periods. In this article there is more flexibility in choosing the scope of the analysis. In addition, revisions are analysed in relation to the stages of the compilation process as outlined above. Analysis is based on a variety of statistical tools and methods as follows:

- using time series graphs to chart the path and behaviour of revisions in different quarters covering the period 1994Q1 to 2003Q4
- analysing summary statistics such as mean revision, mean absolute revision and root mean squared error (RMSE) to measure the size, scope and impact of revisions to GDP and its components. For more details on RMSE see Box 1
- splitting the analysis period in half and using the RMSE to assess whether the reliability of initial estimates has improved or worsened. It is worth noting the second time period will have been through fewer post-BB2 revisions compared with the first period
- using weighted mean absolute revisions to assess the impact revisions to GDP components have on headline GDP. Weighted mean absolute revision is the product of mean absolute revision and proportion of GVA of each component
- applying a statistical test to the mean revisions to test if they are statistically significantly different from zero. For details on testing for significance in revisions see Box 1 in Robinson (2005). The outcome of the test gives an indication of whether the revisions pattern may have occurred by chance rather than due to a systematic overestimation or underestimation of earlier estimates

Box 1

Root Mean Square Error (RMSE)

The root mean square error (RMSE) is a measure that combines the mean revision and the dispersion of revisions (through the variance). It is used to indicate how good an estimator the initial estimate is of the end value.

The formula for calculating the RMSE is:

$$\sqrt{(\text{variance} + \text{mean revision}^2)}$$

where the mean revision is the difference between the preliminary estimate and the later estimate. It represents the expected value of the estimate (preliminary) and the observed value (later estimate).

For example, for M3 to BB1, the RMSE would indicate how good an estimator the M3 value was of the BB1 estimate. This can be done for each stage of the production process, including first to latest.

A low value for the RMSE suggests a better estimator, since a low mean revision and low variance are preferable. An RMSE of zero suggests a perfect estimator while larger values indicate a poor estimator.

An advantage of using the RMSE to assess revisions performance over the mean revision is that the RMSE takes into account the dispersion of the revisions. Thus there could be a very small mean revision (due to an equal number of offsetting positive and negative revisions) which may indicate that it is a good estimator, but the RMSE would take into account the dispersion of the revisions and reflect the large positive and negative revisions to indicate that the preliminary estimate is not a good estimator.

It should be noted, when looking at RMSE as part of the data reliability assessment across two time periods, that it is possible for the performance of the RMSE at each stage to have worsened but for the overall performance to have improved. This is because the RMSE uses the variance at each stage of the process and so a large variance at an individual stage may not necessarily be reflected by a large variance for the total revisions (first to latest). For example, a large negative revision that causes high variance and thus a high RMSE for M3 to BB1 could be offset by a large positive revision at BB1 to BB2. In that case, for total revisions, the large effect on the variance is not seen and therefore not reflected in the RMSE.

Figure 1
Total revisions to quarterly GDP growth, 1994Q1 to 2003Q4

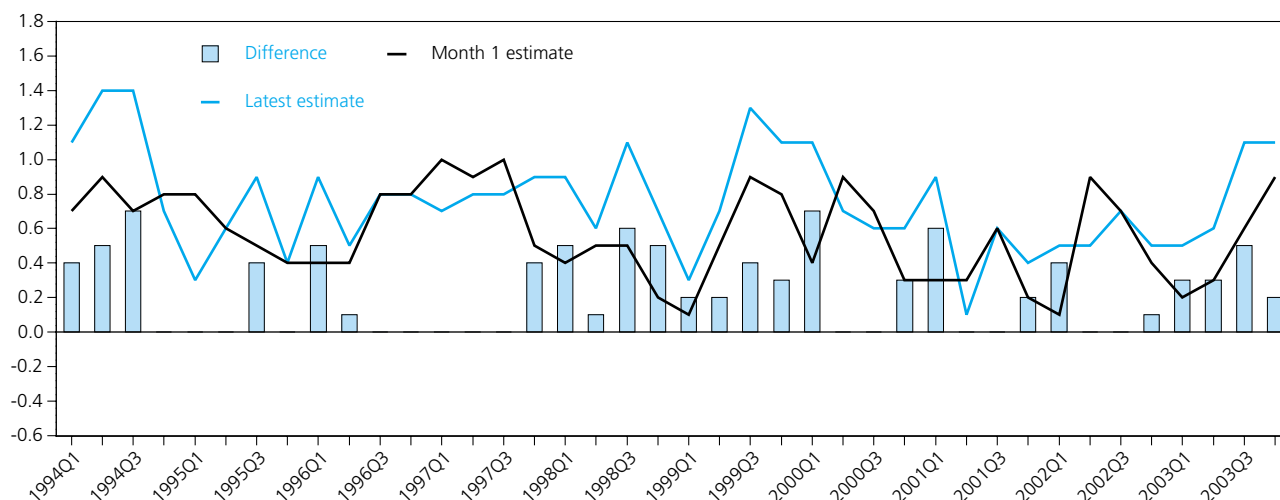
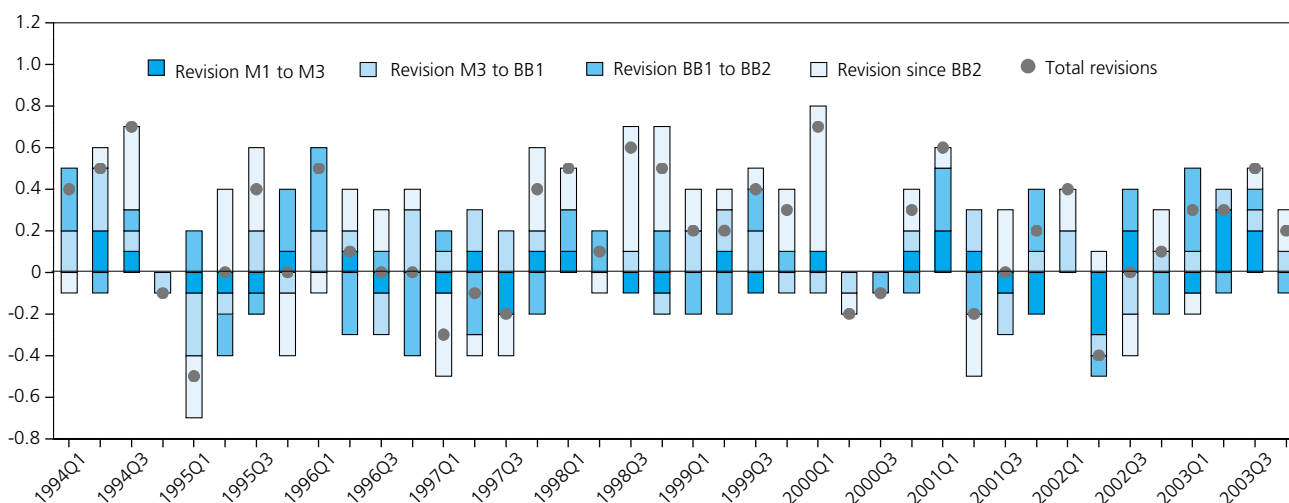


Figure 2
Revisions by stage to quarterly GDP growth, 1994Q1 to 2003Q4



Box 2

Sources of revisions

Revisions are an inevitable consequence of the trade off between timeliness and accuracy, with early estimates based on incomplete data. The sources of revisions can be categorised into five key areas:

1. New data

Revisions caused by new data would include data replacing forecasts, increased survey response rates through late returns and benchmarking of quarterly indicators to annual surveys.

An example is the preliminary estimate of GDP which is based on 44 per cent actual data with the rest forecast. In M2 and M3 for that quarter, the forecasts are replaced with newly received actual data which can result in revisions to earlier estimates. As well as the data causing revisions in itself, new data can also have an effect on the seasonal adjustment of current and past estimates when a full year's worth of data are available for the first time.

In some cases, adjustments are made to the data to compensate for early low survey response, for example the Monthly Inquiry into Distributive and Service Sector (MIDSS) adjustments. MIDSS provides turnover data for over 40 per cent of total services. Adjustments are removed when actual data become available and any discrepancy between the adjustment and the actual data can lead to revisions. For more details see Marks (2006).

2. Balancing

Following any changes to the data, for whatever reason, the three measures of GDP need to be rebalanced to ensure that measures from the production, income and expenditure approach match. This is done quarterly with the output approach as the key driver, but also annually through the Input-Output Supply and Use Tables framework. The balancing in itself can cause revisions to some of the GDP components. Further details are available in Mahajan (1997).

3. Methodological changes

ONS continually aims to improve the quality of its national accounts outputs by investigating potential sources and methods to collect, compile and analyse data. A methodological change is defined as 'a change in sources or calculation used to produce an output'. When changes are proposed, a consistent and rigorous quality assurance process is used to ensure the new method is fit for purpose. For more details see Robinson and Obuwa (2006).

An example of a methodological change is the ongoing implementation of the Index of Services industry reviews which led to improved measurement of the service sector. More details are available at www.statistics.gov.uk/iosmethodology/future_improvements.asp. For further analysis see Tily (2006). This implementation is one of the causes of long-run revisions across some of the services sub-components.

4. New national accounting standards

More rarely, other changes are made to the National Accounts to bring existing practices into line with European or international requirements. This is done as part of the annual exercise to ensure the historical data can be balanced through the Input-Output Supply and Use Tables framework.

A key example of new national accounting standards was the introduction of annual chain-linking which was done in the 2003 Blue Book. More details are available at www.statistics.gov.uk/about/methodology_by_theme/chainlinking/default.asp

5. Error correction

On occasion, revisions are made to the data in order to correct an error. This is very infrequent and is rarely a source of significant revisions.

An example of this would be in the 2006Q2 Quarterly National Accounts publication where there were revisions to the GDP deflator primarily caused by a correction to the exports deflator. This is explained in Annex C at: www.statistics.gov.uk/pdfdir/qnabrief0906.pdf

Analysis of revisions to quarterly GDP growth

Figure 1 shows GDP growth as the preliminary and the latest estimate for any given quarter, with the total revision as the difference. Over the life cycle of a quarterly growth rate up to the latest estimate (as the 2006 Blue Book value), it is evident the initial estimate tends to be revised upwards. Over the time period studied, the revisions range from -0.5 to +0.7 percentage points.

Figure 2 shows the revisions for a given quarter broken down into the different stages of the production process. It shows that revisions can occur in either direction for each stage of the process. Revisions at M1 to M3 and BB1 to BB2 are fairly evenly distributed between positive and negative revisions, while revisions at M3 to BB1 and BB2 to latest are more likely to be positive. It also shows that offsetting revisions can be made for any given quarter at different stages of the process.

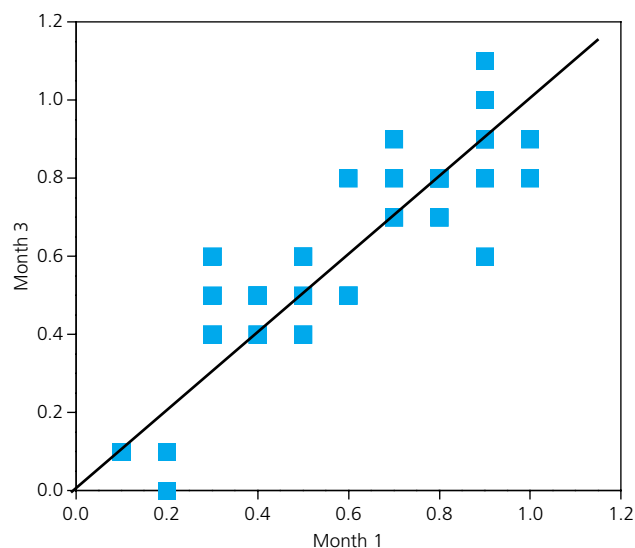
The revisions made at each stage of the process can, to some extent, be reconciled with the reasons for revisions given in Box 2:

- M1 to M3 will usually be caused by new data – data replacing forecasts or further survey returns.
- M3 to BB1 will in general be caused by new data – in the incorporation of annual data.
- BB1 to BB2 shows the effect of annual benchmarking and the balance through the Input-Output Supply and Use framework.
- BB2 to latest are most likely to be caused by methodological changes or the introduction of new national accounting concepts (for example annual chain linking).

Table 1 gives more information about revisions by stage of the production process. It shows that the main stages contributing to the overall revision are those between M3 and BB1, and revisions since BB2. Revisions between M3 and BB1 are likely to have been caused by incorporation of annual data sources, while revisions since BB2 are almost certainly caused by methodological changes and/or changes to national accounting standards (rather than data changes).

While these two stages have the largest mean revision, the mean absolute revision indicates large revisions occurring at different stages of the process but with different signs from one quarter to the next. For example, between BB1 and BB2, the mean revision is 0.02 but the mean absolute revision is

Figure 3
Scatter plot of M1 and M3 estimates for quarterly GDP growth (1994Q1 to 2003Q4)



0.17. The final column shows the RMSE which is explained further in Box 1. In brief, it gives an indication of how good an estimator the initial estimate is of the end value. A low RMSE suggests that the initial value was a good estimator, where a value of zero suggests a perfect estimator. It can be seen from the table that, although the M1 estimate is a good indicator of the M3 estimate, with an RMSE value of 0.13, it is not such a good indicator for the latest estimate as the total revisions RMSE value is 0.36.

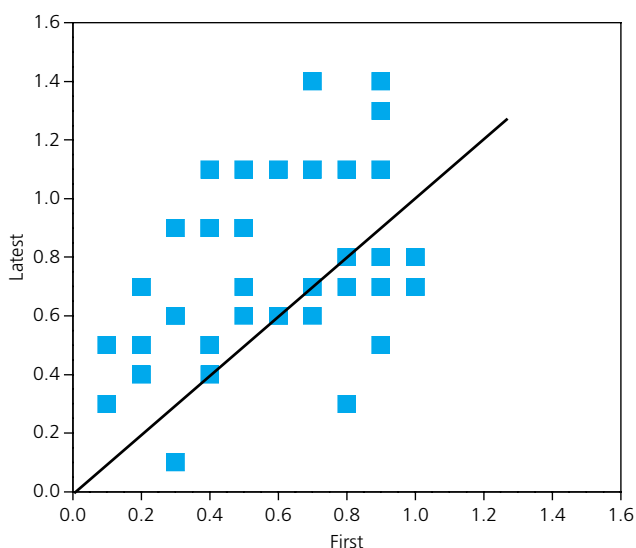
A scatter plot diagram can be used to illustrate the RMSE concept. Figure 3 shows the M1 growth estimates plotted against the M3 growth estimates for each quarter in the sample. Each data point represents a quarter. However, it should be noted that where two quarters have the same value for M1 and M3, the data points will be in the same place and so appear as one data point. Were the M1 value to be a perfect indicator of the M3 value, the data point would lie exactly on the line.

Figure 3 shows that there is a fairly uniform spread of quarters above and below the line – 33 per cent of quarters had a higher M1 estimate (data point below the line), 38 per cent had a lower M1 estimate (data point above the line) and for 30 per cent in the sample, the M1 estimate was the same as the M3 estimate (data point on the line).

Table 1
Summary statistics for revisions to GDP quarterly growth (1994Q1 to 2003Q4)

Revisions period	Mean revision	Mean absolute revision	Variance	RMSE	Statistically significant?
M1 to M3	0.01	0.10	0.02	0.13	No
M3 to BB1	0.05	0.14	0.02	0.16	Yes
BB1 to BB2	0.02	0.17	0.04	0.20	No
BB2 to latest	0.10	0.22	0.06	0.27	Yes
Total revisions	0.18	0.29	0.09	0.36	Yes

Figure 4
Scatter plot of M1 and M3 latest estimates for quarterly GDP growth (1994Q1 to 2003Q4)



If this is compared with another scatter plot (Figure 4), where M1 estimates are plotted against the latest estimate, it is evident that the performance of the M1 estimate worsens over the long term.

In Figure 4, there is a less uniform distribution – 23 per cent of quarters had a higher first estimate (data point below the line), 63 per cent had a lower first estimate (data point above the line) and for 15 per cent in the sample, the first estimate was the same as the latest estimate (data point on the line). This scatter plot confirms that there is a tendency for the first estimate to be revised up at later stages in the production process.

Revisions reflect reliability of the estimates and are used by some analysts to assess data uncertainty. By splitting the time

period used for analysis in half, an assessment can be made as to whether the reliability has improved or worsened by comparing the summary statistics for one period against the other. The first period is 1994Q1 to 1998Q4 and the second period 1999Q1 to 2003Q4.

It is evident from Table 2 that mean revisions at all stages of production (including total mean revisions) are similar in both time periods, the exception being M1 to M3 which has switched sign from a small negative to positive, and BB2 to latest which shows a marked increase in the second period. This is likewise so for mean absolute revisions except for the BB2 to latest stage which shows a marked drop in the second period. This is in part due to the shorter time period open for revisions post-BB2.

The RMSE compared across the two time periods shows a slightly less reliable M1 estimate for indicating the M3 estimate, but improved reliability at each other stage of the process, including for total revisions.

Production (output) components

The production (or output) approach to GDP measures the sum of GVA created through the production of goods and services within the economy. In theory this is the total output less the intermediate consumption of goods and services used up in the production process. However, for short-term measurement and in practice, in volume terms this is done by using proxies for GVA. Examples of such proxies are deflated turnover and volume measures of output.

The output approach in volume terms is actually measuring GVA rather than GDP. GDP is GVA plus taxes on products less subsidies on products. Since it is not possible to split these two items by industry, the output approach measures GVA at industry level.

Table 2
Summary statistics for reliability of estimates in the two time periods

Revisions period	Mean revision		Mean absolute revision		RMSE	
	1st period	2nd period	1st period	2nd period	1st period	2nd period
M1 to M3	-0.01	0.03	0.09	0.11	0.11	0.15
M3 to BB1	0.06	0.05	0.15	0.13	0.18	0.14
BB1 to BB2	0.03	0.02	0.19	0.15	0.23	0.18
BB2 to latest	0.01	0.11	0.26	0.18	0.31	0.24
Total revisions	0.18	0.19	0.30	0.28	0.38	0.34

Note: 1st period represents 1994Q1 to 1998Q4 and 2nd period 1999Q1 to 2003Q4

Table 3
Summary statistics for the main output components, 1996Q1 to 2003Q4

Component	Per cent of GVA (based on 2003 values)	Mean revision	Mean absolute revision	Variance	RMSE	Statistically significant?	Weighted
							mean absolute revision
Agriculture	1.0	0.47	2.15	11.03	3.35	No	0.02
Total production	18.5	0.20	0.63	0.51	0.74	No	0.12
Construction	6.1	0.06	1.01	1.40	1.19	No	0.06
Total services	74.4	0.19	0.31	0.11	0.39	No	0.23

The main industry breakdowns used for the output approach in volume terms are:

- agriculture, forestry and fishing
- total production
- construction, and
- total services

The analysis for the main industry breakdowns covers the period 1996Q1 to 2003Q4 for the M3 estimates, with M2 estimates available from 1998Q4. For total services, M1 estimates are also available from 1998Q4.

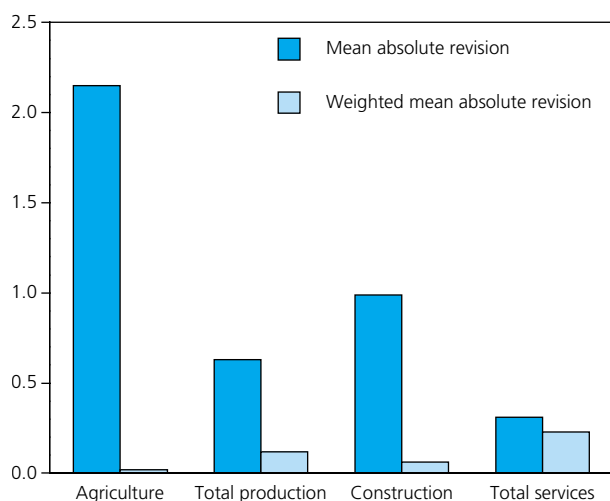
Table 3 shows the summary statistics for revisions (M1 to latest) to growth rates for the main industry breakdown.

The table shows that the largest mean revision is to agriculture at 0.47 percentage points, and the much larger mean absolute revision indicates that there have been both large positive and negative revisions over the time period. Of the main output components, the RMSE indicates that the first estimate for total services is the best indicator of the latest estimate, with agriculture having the least reliable estimate. Although the mean revisions to total production and total services are similar in size, the reliability of the services estimate is due to the lower variance of revisions. None of the mean revisions is statistically significant.

Weighted mean absolute revision is the product of mean absolute revision and proportion of GVA of each component. This is used to assess the impact of revisions to each component on headline GDP.

The weighted mean absolute revision shows that although agriculture has the highest mean absolute revision, its impact on total GVA is minimal as it carries a low weight. Conversely, the mean revision for total services has the largest impact on GVA as a result of its majority weight. This is clearly illustrated in Figure 5, which shows the mean absolute revision alongside the weighted mean absolute revision (using the percentage of GVA for each main component).

Figure 5
Mean absolute revision and weighted mean absolute revision for the main output components, 1996Q1 to 2003Q4



Summary of revisions to production components

Analysis of revisions of quarterly growth rates for the main production (output) components is available in Appendix A, available at www.statistics.gov.uk/cci/article.asp?id=1689

A summary of the results is presented here. They focus on the results of the data reliability assessment which uses the same theory as for the GDP analysis – by splitting the sample of quarters in half, an assessment can be made of whether data reliability is improving or worsening over time.

Agriculture

Total mean revision is smaller in the second period, with mean absolute revision decreasing likewise. RMSE shows that data reliability between the first and latest estimates over the two periods was relatively similar – the estimator for M3 of BB1 and for BB1 of BB2 worsened.

Total production

Both mean revision and mean absolute revision increased in the second period. RMSE shows that data reliability between the first and latest estimates has worsened slightly. This reflects decreased reliability at initial stages of the process, for M3 to BB1 and for BB1 to BB2.

Construction

Total mean revision value switched from positive to negative, with the mean absolute revision increasing. The reliability of the first estimate as an indicator of the latest estimate worsened slightly, driven by the worsening reliability of the BB1 estimate as an indicator of the BB2 estimate.

Total services

Total mean revision is smaller in the second period, with mean absolute revision decreasing likewise. The reliability of the first estimate as an indicator of latest estimate improved considerably, driven by increased reliability for the M3 estimate in reflecting the BB1 estimate.

Total services sub-components

Since total services make up a large proportion of total GVA (74.4 per cent in 2003), an analysis has been carried out on the key sub-components of services.

The breakdown for total services is:

- distribution, hotels and catering
- transport, storage and communication
- business services and finance, and
- government and other services

The analysis for the services breakdown covers the period 1996Q1 to 2003Q4 for the M3 estimates, with M2 estimates available from 1998Q4. For distribution, hotels and catering, M1 estimates are also available from 1998Q4.

Table 4
Summary statistics for the main services sub-components, 1996Q1 to 2003Q4

Component	Per cent of GVA (based on 2003 values)	Mean revision	Mean absolute revision	Variance	RMSE	Statistically significant?	Weighted mean absolute revision
Distribution, hotels and catering	15.3	0.29	0.62	0.49	0.76	Yes	0.09
Transport, storage and communication	7.8	0.43	0.88	1.09	1.14	Yes	0.07
Business services and finance	27.7	0.27	0.58	0.44	0.71	No	0.16
Government and other services	23.5	0.06	0.30	0.16	0.40	No	0.07

Table 4 shows the summary statistics for revisions to growth rates for the main services breakdown.

The table shows that the largest mean revision is to transport, storage and communication, at 0.43 percentage points, and a relatively large mean absolute revision. In contrast, the mean revision for government and other services is small, at 0.06 percentage points, but the mean absolute revision is comparatively much larger, indicating that there have been larger positive and negative revisions in different quarters.

Out of the key services sub-components, the RMSE indicates that the first estimate for government and other services is the best estimator of the latest estimate as it has the lowest RMSE, with transport, storage and communication the least reliable.

The mean revision between first and latest estimates is statistically significant for distribution, hotels and catering and transport, storage and communication. Comparing Table 4 with the corresponding table in Robinson (2005), the changes in mean revisions to the services sub-components are noticeable: transport, storage and communication, and business services and finance have been revised up and government and other services revised down. One of the reasons for these revisions is the Index of Services industry reviews which were implemented in the 2006 Blue Book. Another reason for these revisions was the implementation

of improved allocation of annual coherence adjustments in the 2006 Blue Book. This improvement was first introduced in the 2005 Blue Book for recent periods and was taken back to 1995 for the 2006 Blue Book data set. For more details on Index of Services reviews and the improved allocation of annual coherence adjustments, see Appendix A and published articles, Humphries (2006) and Tily (2006).

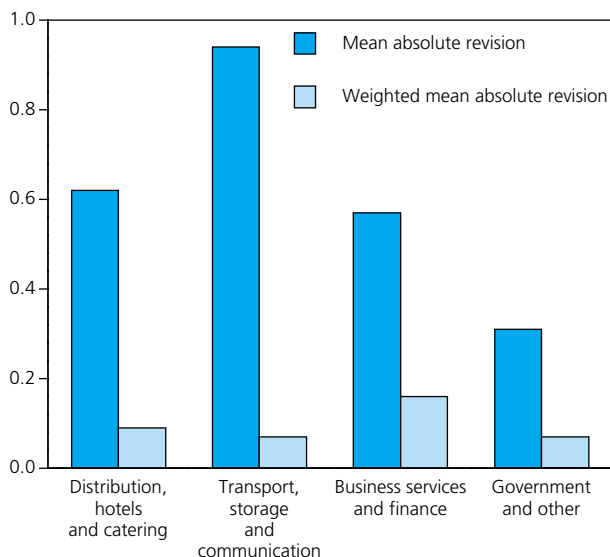
The weighted mean absolute revision shows that, despite having the highest mean absolute revision, transport, storage and communication has minimal impact on total GVA as it carries a low weight. Conversely, the mean revision for business services and finance has the largest impact on GVA largely as a result of its larger weight. This is clearly illustrated in Figure 6, which shows the mean absolute revision alongside the weighted mean absolute revision (using the percentage of GVA for each main component).

Summary of revisions to services sub-components

Analysis of revisions of quarterly growth rates for the key services components is available in Appendix A, available at www.statistics.gov.uk/cci/article.asp?id=1689

A summary of the results is presented here, focusing on the results of the data reliability assessment.

Figure 6
Mean absolute revision and weighted mean absolute revision for the main services sub-components, 1996Q1 to 2003Q4



Distribution, hotels and catering

Data reliability overall has improved in the second period compared with the first, driven by considerable improvements in the BB1 estimate as an indicator of BB2.

Transport, storage and communication

Data reliability has improved at each stage of the process when comparing the two periods, including altogether. The most marked improvements were for M3 as an indicator of BB1.

Business services and finance

Data reliability has improved overall as a result of improved reliability at each stage of the process, most noticeably BB1 to BB2.

Government and other services

Data reliability is better overall in the second period with

a lower RMSE, driven by the further reliability for BB2 in indicating the latest estimate. This is offset to some extent by the worse reliability for the BB1 to BB2 stage.

Expenditure components

The expenditure measure of GDP calculates the total expenditure on final demand for UK-produced goods and services (also described as total domestic expenditure, adjusted for trade). It is broken down into categories according to the purchaser and product. The main components are:

- HHFCE – household final consumption expenditure
- NPISH – final consumption expenditure by non-profit institutions serving households
- GGFCE – general government final consumption expenditure
- GFCF – gross fixed capital formation
- Changes in inventories
- Exports of goods and services
- *less* Imports of goods and services

The analysis of most expenditure components covers the period 1996Q1 to 2003Q4. Expenditure components are first published at M2, and so for this analysis the first revisions period investigated will be M2 to M3 rather than M1 to M3. Analysis for the NPISH component will cover the period 1998Q3 to 2003Q4. This is because NPISH was first published as a separate series in 1998Q3.

Table 5 shows summary statistics for the revisions (M2 to latest) to growth rates of components of the expenditure measure of GDP. Revisions to growth rates of changes in inventories are not included. Analysis of growth rates to changes in inventories would not be meaningful because the underlying estimate is a flow and is published as levels rather than growth.

The table shows that the largest mean revision is to GFCF, at 1.30 percentage points, with a much larger mean absolute revision. The comparatively large RMSE indicates the first estimate at M2 is not a good indicator of the latest estimate.

Mean revisions to exports and imports are relatively large, with a high RMSE indicating the first estimate for both components is not a good indicator of their respective latest estimates. As previously stated in Box 1, an RMSE of zero suggests a perfect estimator while larger values indicate a poor estimator.

For the period covered, mean revision to HHFCE is zero. However, the mean absolute revision of 0.45 percentage points shows that there were small positive and negative revisions, which cancelled each other out over the time period analysed. The comparatively low RMSE of 0.56 percentage points indicates that of all the expenditure components, the first HHFCE estimate is the best indicator of the latest estimate.

Mean revisions to exports and imports are statistically significant largely due to trade associated with VAT Missing Trader Intra-Community (MTIC) fraud. The estimates of the impact of MTIC fraud on the trade statistics are volatile and difficult to predict. It is worth noting, however, that mean revision to the trade balance is not statistically significant. For more detailed analysis of the impact of MTIC fraud on trade statistics, see Ruffles *et al* (2003).

Table 5 also shows that mean revisions to GFCF are statistically significant. The statistical significance to GFCF and exports revisions come despite comparatively large variances indicating there are normally large revisions to these components. Mean revisions to HHFCE, NPISH and GGFCE are not statistically significant.

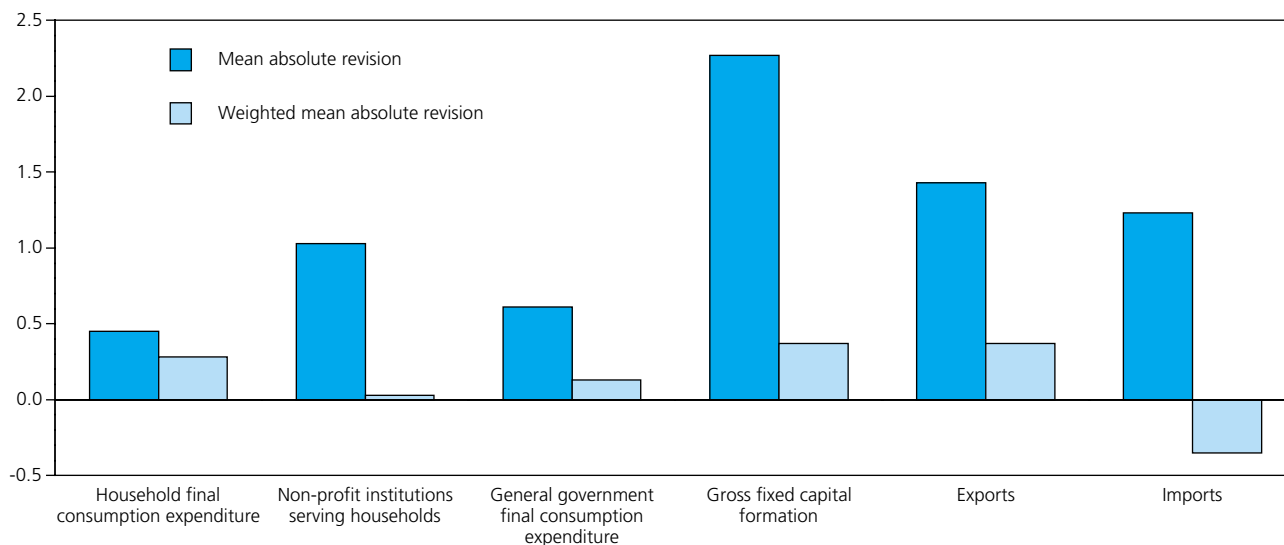
The weighted mean absolute revision in Table 5 shows that revisions to HHFCE have a bigger impact on GDP compared with that made by revisions to GGFCE, despite having a lower mean absolute revision value. This is a reflection of its larger proportion of GDP. The weighted mean absolute revision for NPISH of 0.03 percentage points shows the minimal impact revisions to this component have on overall GDP, compared with HHFCE and GGFCE (see Figure 7). This is the case despite having a comparatively larger mean absolute revision.

Table 5 also shows that, although the mean absolute revision for GFCF is highest at 2.27, because of its smaller proportion of GDP, the overall impact is similar in size to that made by revisions to exports and imports, which both have lower mean absolute revisions. This is clearly illustrated in Figure 7 which shows that the weighted mean absolute revisions

Table 5
Summary statistics for revisions to main expenditure components of GDP, 1996Q1 to 2003Q4

Component	Per cent of GVA (based on 2003 values)	Mean revision	Mean absolute revision	Variance	RMSE	Statistically significant?	Weighted mean absolute revision
Household final consumption expenditure	62.8	0.00	0.45	0.32	0.56	No	0.28
Non-profit institutions serving households	2.4	-0.40	1.03	1.49	1.28	No	0.03
General government final consumption expenditure	21.0	0.00	0.61	0.70	0.83	No	0.13
Gross fixed capital formation	16.1	1.30	2.27	6.49	2.86	Yes	0.37
Exports	25.7	0.81	1.43	3.31	1.99	Yes	0.37
Imports	-28.4	0.63	1.23	1.73	1.46	Yes	-0.35
Inventories	0.4	n/a	n/a	n/a	n/a	n/a	n/a

Figure 7
Mean absolute revision and weighted mean absolute revision for the main expenditure components of GDP, 1996Q1 to 2003Q4



for GFCF, exports and imports are similar in size despite the varying size of the mean absolute revisions.

Summary of revisions to expenditure components

Analysis of revisions to quarterly growth in the expenditure components of GDP is contained in Appendix B available at www.statistics.gov.uk/cci/article.asp?id=1689. As with headline GDP, analysis is based on splitting the time period in half and assessing whether the reliability has improved or worsened. The first period is from 1996Q1 to 1999Q4 and the second from 2000Q1 to 2003Q4, with the exception of NPISH where the first period is from 1998Q3 to 2001Q1 and the second from 2001Q2 to 2003Q4. A summary of the results is presented here.

HHFCE

The results show that the mean total revision changed to a negative in the second period, with the mean absolute revision rising slightly between the periods. The RMSE compared across the two time periods for total revisions shows that the reliability of the M2 estimate as an indicator for the latest estimate is similar.

NPISH

Total mean revision value switched from a positive to negative with the mean absolute revision decreasing, and RMSE showing the reliability of the M2 estimate as an indicator for the latest estimate improved in the second period.

GGFCE

Total mean revision switched from a negative in the first period to a positive in the second period, with mean absolute revision increasing. RMSE indicates that the reliability of estimates in all the stages of production worsened in the second period compared with the first.

GFCF

Total mean revision is larger in the second period compared with the first, with mean absolute revision increasing likewise. RMSE shows that the reliability of the M2 estimate as an indicator of the latest estimate worsened in the second period.

Changes in inventories

In the second period, total mean revision is larger, with mean absolute revision showing a significant increase. The reliability of the M2 estimate as an indicator of the latest estimate worsened markedly.

Exports of goods and services

Total mean revision (M3 to latest) is larger in the second period compared with the first, but the mean absolute revision decreased slightly. The reliability of the M3 estimate as an indicator of the latest estimate slightly improved.

Imports of goods and services

Total mean revision (M3 to latest) is similar in the second period compared with the first; however, mean absolute revision increased. There was no change in the reliability of the M3 estimate as an indicator of the latest value between the two periods.

Income components

The income approach of GDP measures the total income generated by the production of goods and services within the economy. It is broken down into categories according to who has earned the income. The main components are:

- compensation of employees (CoE) – primarily made up of wages and salaries
- public corporations – gross operating surplus of public non-financial corporations

Table 6

Summary statistics for revisions to main income components of GDP, 1998Q2 to 2003Q4

Component	Per cent of GVA (based on 2003 values)	Mean revision	Mean absolute revision	Variance	RMSE	Statistically significant?	Weighted mean absolute revision
Compensation of employees	55.6	0.24	0.41	0.23	0.54	Yes	0.23
Public non-financial corporations	0.7	-2.39	8.03	151.36	12.53	No	0.05
Private non-financial corporations	18.2	0.13	2.23	6.86	2.62	No	0.41
Financial corporations	3.6	6.04	34.42	2,603.77	51.38	No	1.24
Other income	9.2	-0.91	5.15	36.69	6.12	No	0.48
Taxes on products /less subsidies on products	12.7	0.06	1.30	2.60	1.61	No	0.17

- private non-financial corporations (PNFCs) – gross operating surplus of private non-financial corporations
- financial corporations – gross operating surplus of financial corporations
- other income – includes mixed income which covers the income of the self-employed
- taxes on products less subsidies on products

Gross operating surplus is made up of gross trading profits, rental and holding gains/losses of inventories.

Analysis of income components covers the period 1998Q2 to 2003Q4, using seasonally adjusted current price data as opposed to chained volume data used for the output and expenditure components.

Table 6 shows summary statistics for the revisions to growth rates of components of the income measure of GDP. Some income components are first published in M2 and others in M3. For consistency, the revisions analysed in this table are between the M3 and latest estimate.

The table shows that the largest mean revision is to financial corporations at 6.04 percentage points. A markedly larger mean absolute revision indicates there have been both large positive and negative revisions over the period. The mean revision to public corporations is relatively large without regard to sign, and this too has a comparatively larger mean absolute revision.

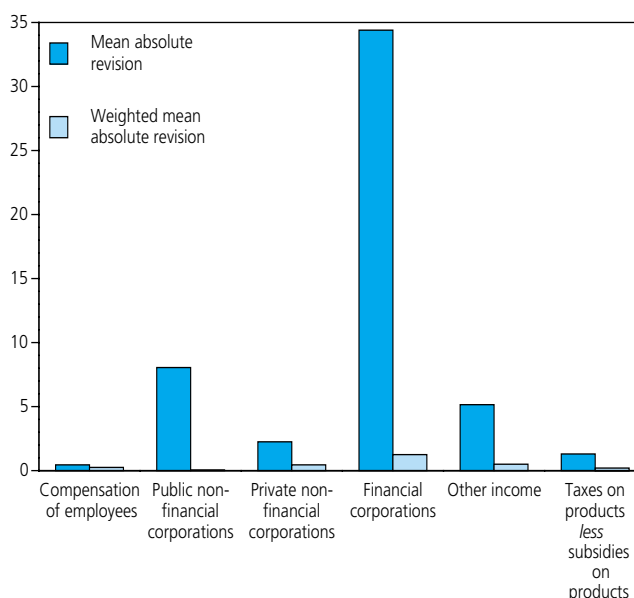
The mean revision to CoE is statistically significant. Despite this, the RMSE indicates of all the income components, the first CoE estimate is the best indicator of its latest estimate. The first estimate for financial corporations is the least reliable indicator of its latest estimate.

In Table 6, weighted mean absolute revision shows that revisions to financial corporations have the biggest impact on GDP, a reflection of the large mean absolute revision to this component. The table also shows that revisions to PNFCs and other income are the other two components with a notable impact on headline GDP. Figure 8 illustrates the comparison between mean absolute revision and weighted mean absolute revision for all the income components.

Also evident from Table 6 is the minimal impact that revisions to CoE and taxes on products less subsidies have on headline GDP, despite together accounting for 68.3 per cent of the

Figure 8

Mean absolute revision and weighted mean absolute revision for the main income components of GDP, 1998Q2 to 2003Q4



income measure. This is mainly due to the low mean absolute revisions of both components.

Summary of revisions to income components

Analysis of revisions to quarterly growth in the income components of GDP is contained in Appendix C available at www.statistics.gov.uk/cci/article.asp?id=1689. As with headline GDP, analysis is based on splitting the time period in half and assessing whether the reliability has improved or worsened. The first period is from 1998Q2 to 2000Q4 and the second from 2001Q1 to 2003Q4.

CoE

The results show that total mean revision and mean absolute revision decreased in the second period. This is reflected in the RMSE, which shows that the reliability of the M3 estimate as an indicator for the latest estimate improved in the second period.

Public non-financial corporations

Total mean revision in both periods is negative, with the second period showing marked improvement (that is to say it is closer to zero). The RMSE shows that the reliability of the M3 estimate as an indicator for the latest estimate improved in the second period.

PNFCs

Total mean revision has switched from a positive in the first period to a negative in the second period, with mean absolute revision increasing. Reliability of the M3 estimate as an indicator for the latest value was similar in the second period.

Private financial corporations

Total mean revision has switched drastically from a negative in the first period to a positive in the second period, with mean absolute revision decreasing. The reliability of the M3 estimate as an indicator for the BB1 and the latest estimate improved significantly in the second period.

Other income

Total mean revision decreased between the two periods, with mean absolute revision decreasing. RMSE shows that the reliability of the M3 estimate as an indicator for the latest estimate improved in the second period.

Taxes on products /less subsidies on products

Total mean revision is unchanged between the two periods, with mean absolute revision decreasing. The reliability of the M3 estimate as an indicator for the latest value improved in the second period.

Acknowledgements

The authors are grateful to all ONS colleagues for comments and assistance with this article, in particular, Simon Humphries, Joe Robjohns, Sanjiv Mahajan, Hugh Skipper and Caroline Lakin.

Notes

1 Due to historical reasons and availability of data, the analyses of revisions to the quarterly growth rates for the components of each of the three measures could not be carried out in all cases for consistent time periods. Details of the time periods which were used for each of the three approaches are outlined just before the analysis.

2 More details covering the Input-Output annual revisions are available in the revision analysis article within the 2006 edition of *UK Input-Output Analysis* publication available at www.statistics.gov.uk/inputoutput

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