

An introduction to reconciled estimates of GDP

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Abstract

This article is an introduction to the process of arriving at reconciled estimates of GDP. First, the process for quarterly short-term estimates is explained. The longer-term Supply and Use process is then covered, whereby the output, income and expenditure approaches of GDP are reconciled.

The process of estimating GDP is highly complex. As this article is a means of introducing less familiar users to the more general principles, it purposely does not go into the detailed calculations that underpin the estimation of GDP. Users looking for additional detail are directed to the suggestions for further reading or can contact National Accounts Coordination Branch by emailing gdp@ons.gsi.gov.uk.

Summary

Gross Domestic Product (GDP) can be estimated by the output (or production), expenditure and income approaches. These approaches are theoretically equal but in the short-term, for quarterly estimates, they will not balance because they use different data sources and methods. Adjustments are therefore needed to provide users with a coherent headline estimate of GDP which is the arithmetic mean (average) of output, expenditure and income approaches.

Even with these adjustments, there still remain 'statistical discrepancies'. These are the difference between the income approach and the headline GDP figure and the difference between the expenditure approach and the headline GDP figure.

After a lag of around one to two years, more data are available and these discrepancies are removed through the Supply and Use balancing Process. This process uses a more robust and detailed set of data and ensures that all three approaches of GDP are fully reconciled by examining products and industry breakdowns.

This article provides an explanation of the various stages of compiling GDP and how quarterly GDP is aligned with annual levels following Supply and Use balancing. After explaining these processes a worked example is provided to illustrate the statistical discrepancies and alignment adjustments.

Quarterly GDP

The three approaches to GDP are explained in the article *Balancing the Three Approaches to GDP*¹. These are:

Output – GDP(O)

The sum of the value added created through the production of goods and services within the economy.

Income – GDP(I)

The total income generated by the production of goods and services within the economy. This includes income earned by companies, employees and the self-employed.

Expenditure – GDP(E)

The total final expenditure on all finished goods and services produced within the economy.

The growth and level of a single quarter will initially be estimated through three releases beginning with the preliminary estimate, around one month following the quarter. This release is solely based on output. In the Second Estimate and the Quarterly National Accounts (third estimate), data are introduced for income and expenditure. The estimation of GDP for a given quarter does not end with the first three releases outlined here. More data are brought in with each quarterly release of GDP and then again data are reviewed as part of the annual Supply and Use balancing process. A statement covering the National Accounts revisions policy is published on the ONS website.²

Unlike the preliminary estimate which uses the output approach only, second and third estimates involve income and expenditure approaches. Until Supply and Use balancing takes place this means there could potentially be three different estimates of GDP for one quarter. This would lead to confusion for users so ONS goes through a process of adjustment and balancing before arriving at a headline estimate of GDP. This headline estimate is an average of the output, income and expenditure approaches.

Estimates of GDP from the three approaches are still published separately within the quarterly releases are presented as being numerically balanced. There are three key elements to getting these approaches to balance which are quality adjustments; alignment adjustments; and the statistical discrepancies.

Quality adjustments

These are the first adjustments to be made in the GDP process. The raw data are examined for potential inconsistencies that would contribute to imbalances in GDP. Essentially the quality adjustments are addressing any issues that may exist within the inputs to GDP calculations and are applied directly to the component data.

Alignment adjustments

In the short-term, output data are considered to be the strongest for reasons of timeliness and reliability of the data, and as such, the path of GDP(O) is the best indicator of the growth of GDP.

¹ <http://www.ons.gov.uk/ons/rel/naa1-rd/united-kingdom-national-accounts/the-blue-book--2012-edition/art---balancing-the-three-approaches-to-measuring-gdp.html#tab-abstract>

² <http://www.ons.gov.uk/ons/guide-method/revisions/revisions-policies-by-theme/economy/national-accounts-revisions-policy.pdf>

However, due to data timing issues, the paths of the individual income and expenditure approaches may not be moving in the same direction. To address any divergence in growth between approaches, alignment adjustments are applied to the income and expenditure components.

The alignment adjustment is applied to the series 'changes in inventories' (of expenditure) and 'gross operating surplus of private non-financial corporations' (of income). However, the alignment adjustments are attempting to ensure the growth is following the same path – not the same level. This means that there still remains a difference between the three approaches and those residuals are the statistical discrepancies.

The alignment adjustments will sum to zero over a year so through the four quarters within a year there could be a combination of negative and positive adjustments. The adjustments have an informal tolerance of +/- £1,500 million per quarter. Larger adjustments indicate that balancing has been particularly difficult for that quarter. Essentially, the alignment adjustment moves growth within income and expenditure approaches between the quarters rather than increasing the overall annual growth – hence adjustments summing to zero over the year.

Alignment adjustments are also present in years that have been balanced through Supply and Use to maintain consistent quarterly paths of GDP(O), GDP(I) and GDP(E).

Contributions of these adjustments to the series within a quarter are published from the second estimate onwards.

Statistical discrepancy

The headline estimate of GDP is an average of the output, income and expenditure estimates. The statistical discrepancies for income and expenditure are explicitly stated for quarters in the second and third estimate publications and later in the Blue Book annual publication. These discrepancies are the difference between the sum of the expenditure components and average GDP; and the difference between the sum of the income components and average GDP. Without the statistical discrepancies GDP(I) and GDP(E) would both be different levels to the headline estimate. For years in which Supply and Use balancing has taken place, the statistical discrepancy is zero as the three approaches have been fully reconciled.

Ratio adjustment

For complete years (i.e. those with four quarters of data) other than adjusting the levels of output, income and expenditure there is no mechanism for influencing the differences between the approaches. However, to forecast the tail of GDP for incomplete years, a process of 'ratio adjustment' is used. The annual ratios are the difference between the levels of GDP(E) & GDP(O) and GDP(I) & GDP(O) series. The assumed difference is what the statistical discrepancy for the individual approaches are forecasted to be on an annual basis.³

In fully reconciled years, following Supply and Use balancing, the individual ratios of Income and Expenditure to Output are 1:1. For years with incomplete data the ratios will not be 1:1 so ONS processing systems forecast the ratio. The system automatically carries forward the latest calculated ratio for the next two annual periods. However, these forecast data are adjustable and play an important part in the balancing process.

³ Internal paper 'GDP Alignment Adjustment', 2010

Supply and Use Balanced Years

Whilst each of the three approaches to GDP is attempting to measure the same economic value, the different sources and the statistical and non-statistical errors associated with these sources means that the totals arrived at by the three approaches are not consistent. The Supply and Use framework represents a structure that allows these sources to be confronted in a coherent way, with the aim of achieving a single measure of GDP.⁴

Supply and Use balancing, is able to arrive at definitive estimates by making use of more detailed indicators that only become available after around 1-2 years. The annual estimates from Supply and Use balancing are published in the Blue Book around 18 months after the end of the year. For example, Blue Book 2014 will include an annual estimate for 2012 that has been balanced through Supply and Use. Also included will be a revised Supply and Use balanced 2011 estimate and the unbalanced, 2013 annual estimate (that has not been through the Supply and Use balancing process, instead using the same process as for the quarterly GDP estimates). The reference year will change from 2010 in Blue Book 2013 to become 2011 in Blue Book 2014.

Supply and Use tables are balanced, when:

For each industry:

Total inputs (from the Use table) ***equals*** Total outputs (from the Supply table)

For each product:

Supply (from the Supply table) ***equals*** Demand (from the Use table)

That is, when the data from the *output, income* and *expenditure* approaches used to fill these tables are balanced, all approaches produce the same estimate of current price GDP at market prices.⁵

Balancing process

The Supply and Use process uses an iterative approach to balancing. Before balancing begins, time is spent assessing the raw inputs in their own right and making any necessary quality adjustments. Where necessary, further specific quality adjustments are also made in the preliminary iterations before the general reconciliation process begins.

For each iteration, the Supply and Use team coordinates around 15 trained staff, each of whom is allotted a specific tranche of industries or products to balance based on their area of expertise. Balancers are given specific guidance after each product and industry phase from a senior steering group of National Accountants and economists, as well as access to supporting sources of evidence. At the end of each iteration, rebalanced industry and/or product data are collated, quality assured and processed through central systems to be recorded and to produce the next iteration.⁶ With each round of balancing the tables are downloaded from central processing systems (known as

⁴ <http://www.ons.gov.uk/ons/guide-method/method-quality/specific/economy/input-output/articles-and-analyses/blue-book-2008---balanced-estimates-of-gdp-using-a-supply-and-use-approach.pdf>

⁵ <http://www.ons.gov.uk/ons/guide-method/method-quality/specific/economy/input-output--uk-national-accounts/articles-and-analyses/uk-national-accounts--gdp-and-i-o-suts.pdf>

⁶ <http://www.ons.gov.uk/ons/guide-method/method-quality/specific/economy/input-output/articles-and-analyses/commentary-on-supply-and-use-balanced-estimates-of-annual-gdp--1997-2011.pdf>

CORD - Central ONS Repository for Data) and adjustments made within spreadsheets. These spreadsheets are then uploaded into CORD and prepared for the next round. When the imbalances are within 0.1% of Total Supply, algorithms using Raking and Scaling (RAS) methods are applied to the remaining small imbalances across products and industries.

Once the Supply and Use tables are balanced, the next stage is to incorporate the reconciled level of GDP into the previously published quarterly estimates. This is presented as a diagram in Annexe A.

Deflation

Before explaining how quarterly estimates are adjusted based on Supply and Use, it is sensible to give a broad description of deflation. Deflated (constant price) GDP is a chained volume measure and has the effects of inflation removed by considering changes in quantity between consecutive periods, holding prices from previous periods constant.⁷

To remove the effects of inflation in years that have been balanced through Supply and Use, the expenditure approach is deflated by appropriate deflators. Income is deflated by the implied deflator derived from GDP(E). The implied deflator is derived as shown in the basic equation below:

A quarterly path of deflated GDP(O) is created, informed by the Monthly Business Survey (MBS) and many other data sources, but pegged to annual GDP(E) from Supply and Use that has been deflated. GDP(E) and GDP(I) are then aligned on a quarterly basis to the deflated GDP(O) path.

Feedback into the quarterly GDP estimates

As discussed earlier, ONS produces estimates of GDP by the output, income and expenditure approaches on a quarterly basis. Supply and Use balancing arrives at an estimate of GDP to which individual output, income and expenditure approaches must be reconciled. Supply and Use arrives at an annual estimate and the quarters that make up a single year must reflect that.

First, levels are provided to teams responsible for compiling the income and expenditure data that are input into the GDP system. This is detailed by product and industry and the data are adjusted to reflect the correct position from Supply and Use. Data are delivered in current prices and previous years' prices from satellite systems to the central CORD Supply and Use system.

The GDP system is run on the Income and Expenditure components of GDP, following which a number of checks are carried out. These checks ensure that the statistical discrepancy is zero i.e. there is no imbalance across the approaches and that alignment adjustments sum to zero over the year. If necessary the component datasets will be revisited until the checks are passed.

This stage involving income and expenditure data is an initial process as balancing individual approaches will resume once the output approach has been adjusted to be coherent with annual levels from Supply and Use balancing. It is not until the output approach is finalised that the quarterly path for income and expenditure will be determined.

⁷ <http://www.ons.gov.uk/ons/guide-method/method-quality/specific/economy/glossary-of-key-economic-terms/glossary-of-key-economic-terms-a-c/index.html#13>

Gross Value Added (GVA) from Supply and Use balancing forms the basis of the GDP(O) weights and is used to create a new estimate of GVA based on the output approach, informing the quarterly path. These weights come from the Supply and Use year that is being balanced for the second time (the reference year). Weights for 114 industry groups are calculated based on the contribution of each industry to the overall economy⁸. Changes to GDP(O) are subject to benchmarking to the annual GDP growth rate via 'coherence adjustments', bringing GDP(O) in line with annual balanced GDP(E).

Coherence adjustments are applied to the output of service industries using a spreadsheet system with RAS algorithms. Service industries receive coherence adjustments as historically they were areas where there was less confidence in the robustness of the data.

The spreadsheets with coherence adjustments are then uploaded into the CORD system. Within CORD, the basic price adjustment is calculated. This converts basic prices into market prices by including taxes on products *less* subsidies. At this point we have four quarters of GDP(O) consistent with annual levels as determined by Supply and Use balancing. Next it is necessary to revisit the quarterly Income and Expenditure GDP approaches.

As the Income and Expenditure levels were previously made coherent with the Supply and Use levels and the Output levels are also consistent with Supply and Use levels, there is no statistical discrepancy. This stage now relies solely on alignment adjustments to ensure that the coherence of the annual levels is reflected in the quarterly path for individual quarters.

⁸ <http://www.ons.gov.uk/ons/guide-method/method-quality/specific/economy/output-approach-to-gdp/concepts/chain-linked-weights.pdf>

Illustrating statistical discrepancies and alignment adjustments

The alignment adjustments and statistical discrepancies can be illustrated by looking first at the GDP estimates in the Quarterly National Accounts publication for Q3 of 2013. In Table 1 below, the alignment adjustment, statistical discrepancy and GDP are presented in current prices from Q1 of 2011 to Q3 of 2013.

Table 1

	Expenditure Alignment Adjustment (DMUN)	Expenditure Statistical Discrepancy (GIXM)	Expenditure (YBHA)	Income Alignment Adjustment (DMUQ)	Income Statistical Discrepancy (GIXQ)	Income (YBHA)
2011 Q1	- 1 061	0	380 237	539	0	380 237
2011 Q2	205	0	381 379	13	0	381 379
2011 Q3	1 795	0	388 054	283	0	388 054
2011 Q4	- 939	0	387 267	- 835	0	387 267
2011	0	0		0	0	
2012 Q1	924	- 793	390 007	- 259	654	390 007
2012 Q2	- 882	- 1 158	387 848	- 790	777	387 848
2012 Q3	- 1 248	- 1 395	391 981	- 480	594	391 981
2012 Q4	1 206	- 1 475	397 334	1 529	120	397 334
2012	0	-4 821		0	2 145	
2013 Q1	3 633	- 1 454	401 596	1 634	- 433	401 596
2013 Q2	- 371	- 1 403	404 147	1 608	- 820	404 147
2013 Q3	1 666	- 1 409	409 813	1 921	- 827	409 813
2013 Q4						
2013 (not complete)	3 428	- 4 266		5 163	- 2 080	

At the time of publishing the Quarterly National Accounts Q3 2013 (which is the third estimate of Q3), the total alignment adjustment for expenditure stands at £3,428 million and £5,163 million for income in 2013 between Q1 and Q3. Given that alignment adjustments must sum to zero over the year, it appears that a negative alignment adjustment would be required in Q4 of -£3,428 million for expenditure and -£5,163 million for income.

However, with data available in the Quarterly National Accounts Q4 2013, it can be seen that this was not actually this case as shown in Table 2. Comparing Table 1 with Table 2, the absolute alignment adjustments for Q1 to Q3 2013 of expenditure have all reduced so the alignment adjustment of Q4 is actually -£969 million. An income alignment adjustment of £996 million is applied to Q4.

Table 2

	Expenditure Alignment Adjustment (DMUN)	Expenditure Statistical Discrepancy (GIXM)	Expenditure (YBHA)	Income Alignment Adjustment (DMUQ)	Income Statistical Discrepancy (GIXQ)	Income (YBHA)
2011 Q1	-1 061	0	380 237	539	0	380 237
2011 Q2	205	0	381 379	13	0	381 379
2011 Q3	1 795	0	388 054	283	0	388 054
2011 Q4	-939	0	387 267	-835	0	387 267
2011	0	0		0	0	
2012 Q1	1 289	-781	389 136	1 082	343	389 136
2012 Q2	-730	-1 228	385 466	-486	515	385 466
2012 Q3	-1 694	-1 657	388 398	-516	652	388 398
2012 Q4	1 135	-2 041	395 415	-80	741	395 415
2012	0	-4 145		0	2 251	
2013 Q1	2 581	-2 333	398 545	17	784	398 545
2013 Q2	-2 226	-2 532	398 898	-195	795	398 898
2013 Q3	614	-2 688	404 689	-818	806	404 689
2013 Q4	-969	-2 776	411 259	996	818	411 259
2013	0	-10 329		0	3 203	

In Table 2, for annual GDP in 2013 there is a total negative expenditure statistical discrepancy of £10,329 million – expenditure is higher than the headline GDP estimate. Income on the other hand has a positive discrepancy of £3,203 million so is lower than the headline GDP estimate.

Looking back to 2011 which has been through the Supply and Use balancing process for Blue Book 2013, it can be seen that the statistical discrepancies have been removed and both expenditure and income approaches have been fully reconciled. Readers can also see that the expenditure alignment

adjustment for Q1 of 2013 was particularly large at £2,581 million. This would indicate it was a particularly difficult quarter to balance.

Conclusion

This article has described how GDP is led in the short-term by the output approach, GDP(O) and reconciled estimates are arrived at following Supply and Use balancing.

When GDP is first estimated, only output data are included. In the second and third estimates, roughly two and three months after the quarter, balancing is used to align the three different approaches. This is done through quality adjustments of the raw data and applying alignment adjustments to bring the direction of growth of income and expenditure (not levels) in line with output. A residual will still exist between headline (average) GDP and the income and expenditure approaches – these are the statistical discrepancies.

Around 18 months following the end of the year, Supply and Use balancing estimates of GDP are published, making use of more detailed, annual sources. This process removes any statistical discrepancies and the three approaches are fully reconciled.

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Further reading

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<http://www.ons.gov.uk/ons/interactive/ons-statistics-products/index.html>

Infographic: *How is GDP calculated?*

<http://www.ons.gov.uk/ons/rel/naa2/second-estimate-of-gdp/q4-2013/sty-calculating-gdp.html>

Infographic: *Quarterly GDP revisions infographic*

<http://www.ons.gov.uk/ons/rel/elmr/explaining-economic-statistics/quarterly-gdp-revisions/info-quarterly-gdp-revisions.html>

Annexe A

Revising Quarterly GDP based on Supply and Use Balanced Estimates

